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INDIA'S FOREST WEALTH

INDIA OF TO-DAY

(Under the General Editorship of Prof. L. Rushbrook Williams, C.B.E., Director Public Information.)

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By C. F. STRICKLAND.

,, II. The Defence of India. By ARTHUR V
CENT. (Second impression.)

,, III. Irrigation in India. By D. G. HA
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Plate I.

Wild elephant in bamboo jungle.

Two important items of India's forest wealth. *Frontispiece.*

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FOR CONSULTATION ONLY

INDIA OF TO-DAY

VOLUME VI

INDIA'S FOREST WEALTH

BY

E. A. SMYTHIES, B.A.

Officiating Conservator of Forests,
Working Plans Circle, U.P.

SECOND EDITION

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PREFACE

THE compilation and writing of this book was taken up at the request of the Publicity Commissioner. It is true that the forests of India have since the commencement of the Great War received much more publicity than they ever received before, and during the last two or three years especially the publication of several important books and pamphlets, the commencement of public lectures with lantern slides on forest subjects, and similar forms of activity, have widened the sphere of interest and disseminated knowledge on a subject on which formerly Government officials, politicians, commercial firms and the general public were frequently profoundly ignorant. But in recent years no book has been written which, dealing with India as a whole, describes and discusses the economic wealth of India's forests. Troup's great work, *The Silviculture of Indian Trees*, touches only cursorily and indirectly on their economic value. Stebbing's *The Forests of India* describes the gradual building up and development of the organization and management of the great forest estate, but the economic value, the value of exports and the uses of forest products, and so forth, do not come within the scope of the book. Pearson's *Economic Forest Products* is a standard work of reference, but being more or less of a catalogue, cannot do justice to some of the most important aspects of Indian forests, as for example their importance in the economic life of the vast agricultural community. Nor can it indicate *regions* or areas of potential wealth and future possibilities. There are numerous research and provincial publications dealing with special products or special areas, which have been freely utilized in the compilation of this book, as for example the pamphlets issued by Burma and the Punjab giving a comprehensive description of the forest wealth and products of those provinces, also the U. P. Government publication, *Practical Forest Management*, which has been freely utilized in the opening chapters of this book; but such publications are obviously limited in their scope. To a certain extent therefore this little book breaks new ground, or it might be more correct to say treats an old subject in a new way. It does not profess to be a manual or text-book; to write a complete and exhaustive text-book on the economic value of all the products of Indian forests would be the work of a lifetime. Even the compilation of this little work would have been impossible without the cordial co-operation of forest officers in all parts of India, and the author desires to acknowledge the very valuable help and useful notes he has received from Messrs. Blanford, Gibson, Harlow, Nicholson, Bourke, Clear, Greswell, and especially the assistance given by Mr. Pearson, C.I.E. (Imperial Forest Economist), who has freely placed at the author's disposal his unique knowledge of the forests of India and their products, and the accumulated mass of information available in the Research Office at Dehra Dun. If there is any merit in the book, it is due rather to this band of experts and local knowledge than to the author.

November, 1923. E. A. SMYTHIES

MINISTRY OF CULTURE · GOVERNMENT OF INDIA

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CONTENTS

CHAP.		PAGE
	PREFACE	v
	LIST OF ILLUSTRATIONS	ix
	INTRODUCTION. By P. H. Clutterbuck, C.I.E., Inspector-General of Forests, India	xi
I.	FOREST AND CIVILIZATION	1
II.	PAST HISTORY OF INDIAN FORESTS ...	5
III.	FORESTS AND AGRICULTURE	10
IV.	THE FORESTS OF INDIA	22
	(1) The Punjab and Frontier Tracts ...	25
	(2) The Upper Gangetic Plain— Forests of United Provinces and Nepal	32
	(3) The Lower Gangetic Plain— Forests of Bengal, Assam, Chittagong	35
	(4) Forests of Bihar and Orissa, Central Provinces and Berar	44
	(5) Forests of Bombay, Gujarat, and the Western Peninsula ...	49
	(6) Forests of Madras and Southern India	56
	(7) Forests of Burma	64
	(8) Forests of the Andaman Islands ...	75

CHAP. PAGE

V. MINOR FOREST PRODUCE 80
- (1) The Indian Pine-Resin Industry ... 80
- (2) The Paper Pulp Industry ... 85
- (3) Tanning Materials 88
- (4) Essential Oils 93
- (5) Lac 95
- (6) 'Boswellia serrata' Gum-Resin ... 102
- (7) Cutch and Katha 105
- (8) Drugs and Medicinal Herbs ... 106
- (9) The Bassia Tree and its Products ... 110
- (10) Oil Seeds 115
- (11) Canes 116
- (12) Fibres 116

VI. FUTURE POSSIBILITIES 118

BIBLIOGRAPHY 136

MINISTRY OF CULTURE · GOVERNMENT OF INDIA

GSL

LIST OF DIAGRAMS AND ILLUSTRATIONS

To face page

1. Wild elephant in bamboo jungle—Two important items of India's forest wealth *Frontispiece*
2. Diagram showing the steady rise in revenue and surplus from the forests of British India (1864-69 to 1914-19) 8
3. The Forest Research Institute, Dehra Dun.. 10
4. Deodar forest in the Punjab—The sacred tree of the Himalayas 26
5. Fine *sal* forest of the submontane zone ... 32
6. Up the Kasalong River—Virgin forests of the Chittagong Hill Tracts 40
7. Export of bamboos on the Kasalong River, Chittagong Hill Tracts 43
8. Nilambur teak plantation, Madras Presidency. 60
9. Natural reproduction of teak, the great timber tree of Burma 70
10. Fine *Dipterocarp* forest, Toungoo, Burma ... 74
11. Intensive Forest Management in Bengal: Clear-felling followed by ploughing and sowing 121
12. North-Western Railway creosoting plant, Punjab 125

GENERAL EDITOR'S NOTE

THE opinions expressed in this book are those of the author. No other person shares responsibility for them.

L. F. RUSHBROOK WILLIAMS
General Editor

INTRODUCTION

THE forest lands of India and Burma under the management of the Forest Department amount approximately to 160 million acres, which is nearly one-fourth of British India. It follows that if the average net revenue of one acre is 1½ anna (1½*d.*) per annum, the total net revenue would be 1½ crore of rupees, or one million pounds sterling. Actually the net revenue is now approximately two crores of rupees, which means that India is at present getting an average income of only 2 annas net per acre from her forest estates. On the other hand, some of the best forests favourably situated for markets and under intensive management are already yielding as much as Rs. 15 net per acre per annum. If the *average* net revenue could be raised to Rs. 3 per acre per annum the total net annual revenue would amount to 48 crores of rupees, or 32 million pounds sterling. This is not too high an ideal to aim at. The greater part of the forests is not yet intensively worked and in fact there are very large areas still which are not worked at all. These await development chiefly by improvement of communications. Also the growing stock in the forests which are intensively worked has in many cases increased enormously as the result of conservation, protection tending and in some cases planting, during the past sixty years. This increase of value in growing stock, as a direct result of the work of the Forest Department, is not sufficiently emphasized in any of the usual reports for the simple reason that we have no ready means of estimating the value of the growing stock for such large areas at frequent intervals.

We do, however, know instances that will illustrate this point. In one case thirty-seven years after the crop had been accurately measured the volume was found to be actually four times greater than it was at the previous survey in spite of heavy feelings of over-mature trees which had taken place in the meanwhile.

The proper conservation of forests has been the policy now for about fifty years. The new crops that have been nursed up during this time in place of the more or less ruined crops which previously existed are now about half grown. It may be stated with safety that in a great many parts the revenue has up till now been, and still is, derived from the remnants of forests which had been more or less ruined before the Forest Department came into being, whereas the revenue of the future, after a few more decades, will be from the new crops referred to above. This clearly shows that provided the policy of conservation is maintained the revenues in the future will undoubtedly increase by leaps and bounds as time goes on.

Forests are a national asset and civilization is in urgent need of them. Not only do they provide supplies of timber and produce and incidentally give a revenue to the State, but their indirect advantages are even more important. To an agricultural country like India, the importance of forests cannot be exaggerated. Dr. Voelcker, who toured in India in the early nineties and reported on the possibilities of the improvement of Indian agriculture, stated that the Forest Department had come into existence in the nick of time, and by saving the forests which then still existed, had done an untold benefit to agriculture. Throughout his report he impressed time and again the utmost importance of adding to the existing forests by creating new fuel and fodder reserves on waste lands. In addition to being advantageous to agriculture, which is the greatest industry in India, forests have a marked effect on the climate and on the maintenance of water supply. Forests in India are also a valuable asset in times of famine and scarcity for they are not only capable of yielding vast quantities of fodder, even though much of it is of poor quality, but can also at a pinch yield large quantities of edible fruits and roots of which the poor people in times of famine readily avail themselves. But perhaps the greatest asset of forests in India is the checking of erosion and preventing the good soil from being washed into the rivers and carried into the sea. Finally forests directly increase the fertility of the soil on which they grow. Trees are capable of making rich vegetable mould from mineral soils. An illustration of how forests improve locality may be given. The quality of a locality in the forest is estimated by the rate of growth of the trees and the height and size to which they grow. At the original investigation one locality was found to be low in the second class; after four decades of conservation and intensive management it was found that the locality had greatly improved to the extent of becoming super first class. To sum up, therefore, it seems hard to exaggerate how important forests are to a civilized nation.

These remarks have been inserted here as the tendency, more especially since the war, has been to magnify the commercial side of forestry to the belittlement of the scientific side and the indirect advantages to the country. After all the growing of the crop of timber trees is what takes time, usually the best part of a century, but the cutting down of the same can be done very quickly.

This little book is especially designed to increase public interest in the forests of India. The wealth is no doubt there, as will be realized by a perusal of this book, but, taken in conjunction with the remarks above, it must also be realized that their potential value to the coming generations is infinitely greater.

It may be interesting to know how India stands in comparison with a few other countries. The United States of America have in the past two decades organized their national forest areas amounting to practically the same acreage as lands under the Forest Department in India. From the latest returns we have, that country is paying out to the extent of sixty lakhs of rupees per annum in order to build up and manage its forest estates. So that instead of getting a large revenue as India already does, its forests are managed at a loss. The State forests of Canada too are not yet a paying concern. In New Zealand owing to the destruction of forests a Forest Department has recently been started. In that country the State has not sufficient funds to build up a forest property from revenue and it is consequently organizing its forests and its Forest Department with loan money by treating the whole expenditure on forests as capital until they become in due course a paying proposition.

The author is well known in India as one of the foremost authorities on forest organization and silviculture. He is to be heartily congratulated on the production of this book, which appears most opportunely since the necessity for the development of natural resources is just now more urgent than ever. Mr. Smythies has made the best possible use of the limited space at his disposal.

Owing to the work which has already been accomplished in the past India now leads in forestry in the Empire by half a century. It is to be hoped that this fact will become generally recognized so that there may

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be no danger of any reversal of policy regarding conservation of forests. This is a non-political matter and it is trusted that all parties will keep the subject out of the sphere of politics and support the necessary policy continuously.

Plate No. 1 is by Mr. F. W. Champion and the remainder are from the collection of the Forest Research Institute, Dehra Dun.

P. H. CLUTTERBUCK

CHAPTER I

FOREST AND CIVILIZATION

BEFORE the dawn of civilization in the days of primeval man, the greater part of the habitable globe was clothed with dense forests, because the vegetation which composes the different forest types represents the climax vegetation which has gradually come into existence in the course of ages and by the processes of evolution. Thus forest trees were enabled to monopolize most of the fertile tracts of the Earth, and the extension of forest was limited only by physical causes, such as ice and snow in the high latitudes and altitudes, drought and absence of moisture in deserts and dry savannahs, excess of moisture in bogs and swamps, and so on. With the evolution of Man, and in the course of ages, the distribution of forests was profoundly affected. At first the progenitors of Man were insignificant individuals, wandering in the depths of the primeval and gigantic forests, on which they were dependent for the necessities of their existence; the forest was their home, and the trees of the forest their gods. But gradually Man became gregarious, collected into tribes and communities, started an agricultural and pastoral existence clearing the land in ever widening circles for cultivation and grazing, and the first great onslaught on the forest growth commenced, a long sustained attack, which, starting ten thousand years or more ago, still continues with accelerated fury at the present day. The destruction of forests was however not uniform, but varied directly with the stage of civilization reached. Thus two thousand years ago, the savages of Britain and Germany had made little or no impression on their forests, which formed an almost impenetrable barrier to the might and arms of imperial Rome, while the civilizations of Greece and Rome had very largely converted their forest lands into cultivation and the still older civilizations of Persia and Babylon had already largely destroyed the vestiges of their forests, and incidentally destroyed themselves as well. In the last 200 years the great expansion of civilized life in the North American continent has resulted in the disappearance of unknown millions of acres of virgin forests. In China, in India, in every densely inhabited part of the earth, we find the same result, the destruction of forests with the expansion of civilization, and at the present time the relics of the once all embracing primeval forests are to be found only in those regions where the onslaughts of man and the pressure of civilized life have not yet commenced, in the wild uninhabited tracts of South America and Central Africa, Siberia and North Canada, Burma and the Malay Archipelago.

But while the random development of thoughtless civilization has had the world-wide effect of destroying the forests of the world, at the same time modern industrial civilization is dependent more and more on the produce of forests for its existence, an apparent paradox, the truth of which was realized by the French and Germans a century or two ago, in India fifty or sixty years ago, was vividly impressed on the British nation during the course of the Great War, and is at the present time causing serious consideration to the more enlightened governments throughout the world. In the chapters that follow, some slight indication will be given of the extremely varied demands that modern civilization makes on forests, as illustrated by the utilization of different products from the forests of India and Burma. The dependence of the aboriginal savage of Africa or Borneo on the virgin forests in which he lives is fairly obvious, and in reality, the inhabitants of London, Paris or New York are just as dependent on the products of forest growth as any aboriginal savage, although the connection is not at first so obvious, and the value of forest products consumed annually per head of population increases rapidly with the industrial development of a nation.

But the necessity for the existence of forests goes deeper than the mere utilization of their products. The careless destruction of forests on mountain slopes brings into operation such forces of erosion and denudation, resulting in landslips, tremendous floods, silting and destruction of fertile valley land, that Man is rendered helpless, and even mighty empires (such as Babylon) are obliterated, or (as in China) whole populations, running into millions of people, are rendered homeless and destitute. The importance of forest growth in the regulation and conservation of water supply is well recognized, and this recognition has resulted, for example, in the afforestation of catchment areas for the water supply of large cities such as Liverpool and Manchester. The effects of forests on climate are not so clearly established, but there are reasons to think that the burning climate of the plains of India, or Persia and elsewhere, are to some extent at least aggravated by the complete removal of forests which once clothed those tracts. To give one illustration of the reverse side of the picture, the successful afforestation of wide expanses of infertile sand dunes along the shores of the Bay of Biscay a century or more ago, checked the continuous encroachment of sand and continuous conversion of fertile lands into barren wastes, and created instead some of the most valuable and intensively worked pine forests in Europe, creating at the same time a never failing supply of pit props for the Welsh collieries, and of turpentine and rosin for the industries of Europe. The Landes of France provide possibly the finest example of successful and profitable afforestation on a large scale to be found in the world to-day.

This brief summary of the connection between civilization and forests is a necessary prelude to a more detailed consideration of India's forest wealth. It has been shown what a profound effect the advent and development of Man on the earth has had on the distribution of natural forests, and how in every country the primeval forests have had to disappear before the advance of civilization. But the great lesson to be learnt at the present time is that as modern civilization is largely dependent on forest products, a definite minimum area of land under forest is an economic and physical necessity for the well-being of every civilized nation. Those nations (such as Great Britain and South Africa) which by nature or past neglect have now an inadequate area of forest land find themselves compelled at great expense artificially to create or re-create their forests by plantations. Other nations, such as Germany, France, Sweden, and India, have grappled with the problem in time, and taken adequate steps to ensure the protection and continued existence of their forests. Other countries again, notably the United States of America, have more recently realized the economic necessity of adequate forest areas, and are busy with the problem of ensuring the future needs of the nation. In the chapters that follow an attempt will be made to show what India has done in the past to protect and develop her forests, their types and distribution, their physical and economic value, their utilization and future prospects.

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CHAPTER II

PAST HISTORY OF INDIAN FORESTS

'Les forêts précèdent les peuples, les déserts les suivront.' So wrote a great French forester, and the underlying truth of his remark can be exemplified in various parts of India. There can be little doubt that once a primeval forest stretched over the greater part of the land, except in such inhospitable tracts as the high altitudes of the Himalaya, or the arid deserts of Rajputana and Sind. In the Vedas, the earliest religious writings of the Hindus, which are partly historical and partly mythical, in the epic poem of the *Mahabharat* about the time of the Aryan invasion of Hindustan, references are made to dark, gloomy forests in areas recognized as situated in the Gangetic plain, now a vast expanse of cultivation and for a thousand miles or more devoid of forest growth. Similarly the records of the wanderings of the Chinese pilgrims (about 600 B.C.) frequently speak of leagues and leagues of dark and dismal forests in the now almost treeless districts of Gorakhpur and Western Bengal. In much later times, in the sixteenth century A.D. the Moghul Emperor Babar hunted tiger and other large denizens of the forests along the Jumna river, in areas which have now become barren ravine deserts of stunted thorny shrubs.

In the turbulent days of early Indian history with the rise and fall of dynasties and powers, the areas of forest lands fluctuated, shrinking to make place for cultivation with the advent of a strong ruler, increasing again with the collapse of the central power, or when wars and pestilence and famines reduced the density and pressure of the population. Thus we still find ruined and long-forgotten cities in some parts of India, in the depths of the forest, which came back again when the inhabitants were massacred or the cities were deserted. With the advent of the stabilized rule of the British Raj, resulting in a great increase of population, with the attendant demand for timber and fuel, with the spread of agriculture and the increase of pastoral herds, and the introduction of modern industrial conditions, with the greatly increased demand for constructional timber, for sleepers for railways and a hundred other uses, a fierce onslaught was commenced on the forest areas, and by the middle of the nineteenth century the depletion of the forests began to assume a serious aspect.

It was, however, by no means for want of advice and warning that little of a practical and enduring nature was accomplished during the first half of last century, for various officers were deputed from time to time to report on the forests of different localities, and all were insistent on the need for the conservation and improvement of the forest tracts inspected by them. Thus as early as 1827 Dr. Wallich reported on the forest resources of Tenasserim, while about 1837 Dr. Helfer reported on those of Malabar; in 1847 Dr. Gibson was appointed Conservator of Forests, Bombay, while in 1856 Dr. Cleghorn was appointed to a similar post in Madras, and both these officers submitted valuable reports on the forests in their charge. During this period the name of Mr. Conolly, Collector of Malabar, stands out conspicuous. This officer, keenly alive to the dangers attending the depletion of the forests in his district and anxious to ensure the future local supply of teak timber, founded in 1842 the now famous Nilambur teak plantations, which have been regularly extended to the present day, and which form a living monument to their founder and to those who have had a share in the work of their extension.

The year 1855 marked the commencement of a new era in the history of the forests of India, for it was then that Lord Dalhousie laid down a definite and far-sighted forest policy. Further progress was delayed for a time by the Mutiny, but, in 1862, owing largely to the increasing difficulty of obtaining adequate supplies of timber for the great extension of railway lines then being undertaken, as a result of the systematic destruction of forest areas for cultivation, of uncontrolled felling and absence of all protection of forests, the Government of India were forced to take energetic steps to protect from further destruction the forests that still survived, and forest organization was rapidly extended to all the provinces in India.

The earlier years[1] of forest administration were beset with difficulties, which is not surprising considering that the newly created Forest Department was charged with the unpopular duty of protecting the heritage of nature from the rapacity and thoughtlessness of mankind, a duty which naturally roused considerable antagonism. Brandis' early struggles in Burma are but one instance of the contest against greed, ignorance and short-sightedness, for his efforts at introducing sound principles of organization and protection met with a storm of opposition from all sides, and particularly from mercantile firms engaged in the timber business. The conflict raged for five years, but in spite of gross misrepresentations, his policy prevailed in the main: had this not been the case matters would certainly have gone from bad to worse, and the valuable teak forests of Burma, instead of yielding a steady and increasing supply of timber, would by this time have been depleted of the bulk of their marketable trees. Such a contingency would have been a national disaster; for it is on first-class teak that our Admiralty relies for its supplies of the best shipbuilding timber.

In other provinces also the early years of the Forest Department were marked by a constant struggle against opposition in various forms, for although Government had proclaimed its forest policy, this policy was not always appreciated by district officials, many of whom were unable to discern the potential value of the forest or to foresee the baneful results of their destruction.

Exploration, demarcation and settlement, followed by efforts to introduce protection and some form of regular management, were the first duties of the Forest Department. Work on these lines, which is not yet completed in the more backward part of the country, has been pursued steadily from the commencement, and in consequence large tracts of forest have been saved from ruin and are gradually being brought under efficient management. Whatever may have been the opinions held in some quarters half a century ago as to the need for a policy such as that expressed in Lord Dalhousie's memorable enunciation of 1855, there is no longer any doubt that results have amply justified the steps taken and that in her forests India now possesses a property of constantly increasing value, the future importance of which it is hardly possible to over-estimate.

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[1] *Work of the Forest Department in India*, 1920.

The accompanying diagram illustrates the steady increase in cash revenue and surplus from the forests of British India over a period of half a century (from 1864-69 to 1914-19). From this it will be seen that the total revenue and surplus were 3·7 million and 1·2 million rupees in 1864-69, and have increased to 37·5 million and 16·0 million rupees [1] in 1914-19, more than a ten-fold increase in either case. In addition, the value of forest produce given away free or at reduced rates to concessionists and right holders averaged over nine million rupees yearly in the period 1914-19. These are large figures, but it must be emphasized that they only represent a proportion of the increased value of the forest estate. For, fifty years ago, the more accessible and more valuable forests were in a semi-ruined state as a result of the uncontrolled felling, burning, grazing and other forms of damage to which they had been subjected during the previous half century or more. In many cases all the best trees had been felled and the refuse left. With the advent of adequate protection a new young crop gradually came in, and these ruined forests have been filling up with healthy young trees ever since, but it will still be several decades before these young crops are ready for felling and before the forests reach their full productivity.

But apart from the gradual increase and value of the tree crop in the more accessible forests, a proportion of the steady increase in revenue has been due to the gradual

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[1] 15 million rupees = 1 million pounds.

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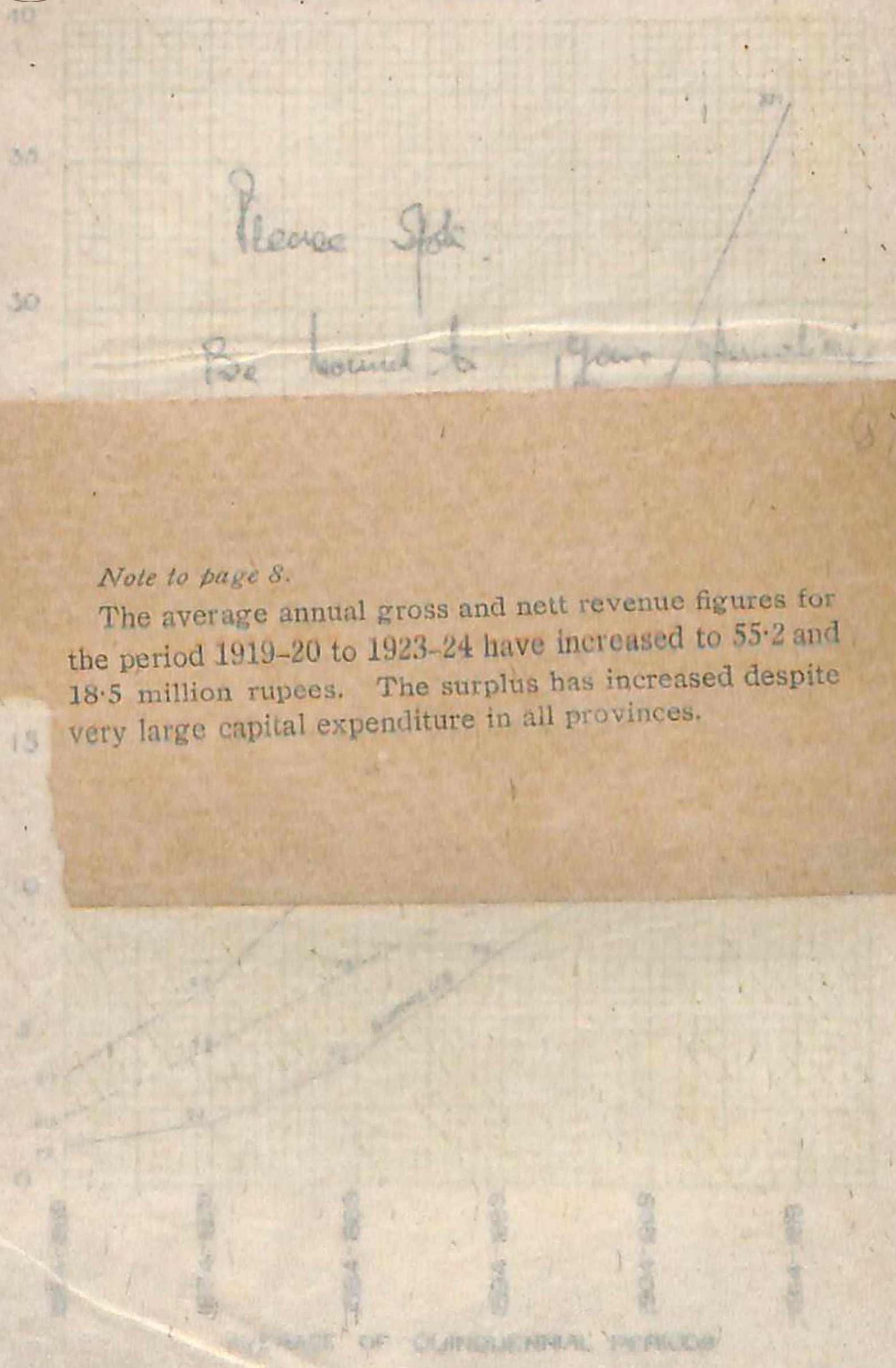

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The average annual gross and nett revenue figures for the period 1919-20 to 1923-24 have increased to 55·2 and 18·5 million rupees. The surplus has increased despite very large capital expenditure in all provinces.

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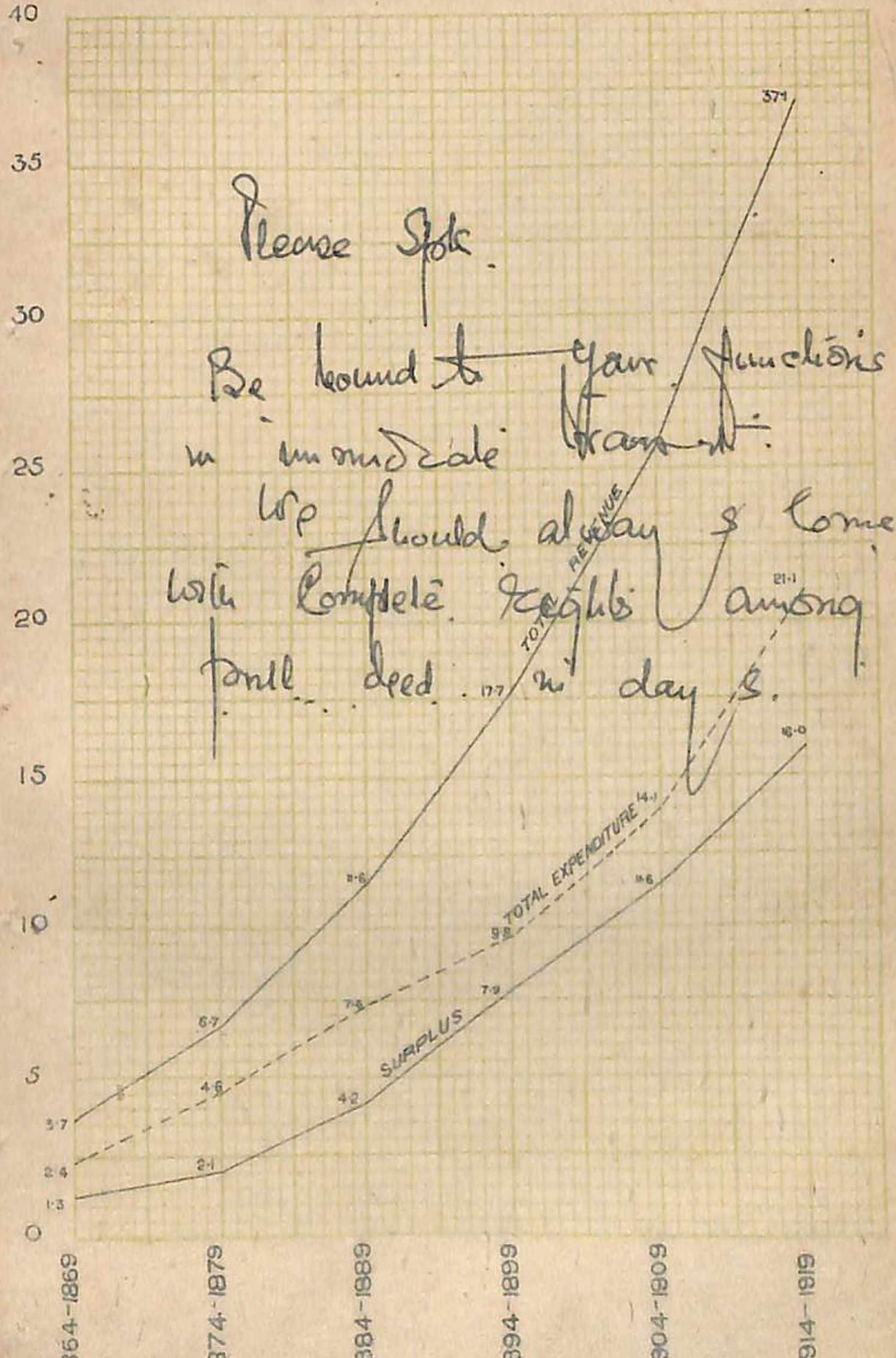

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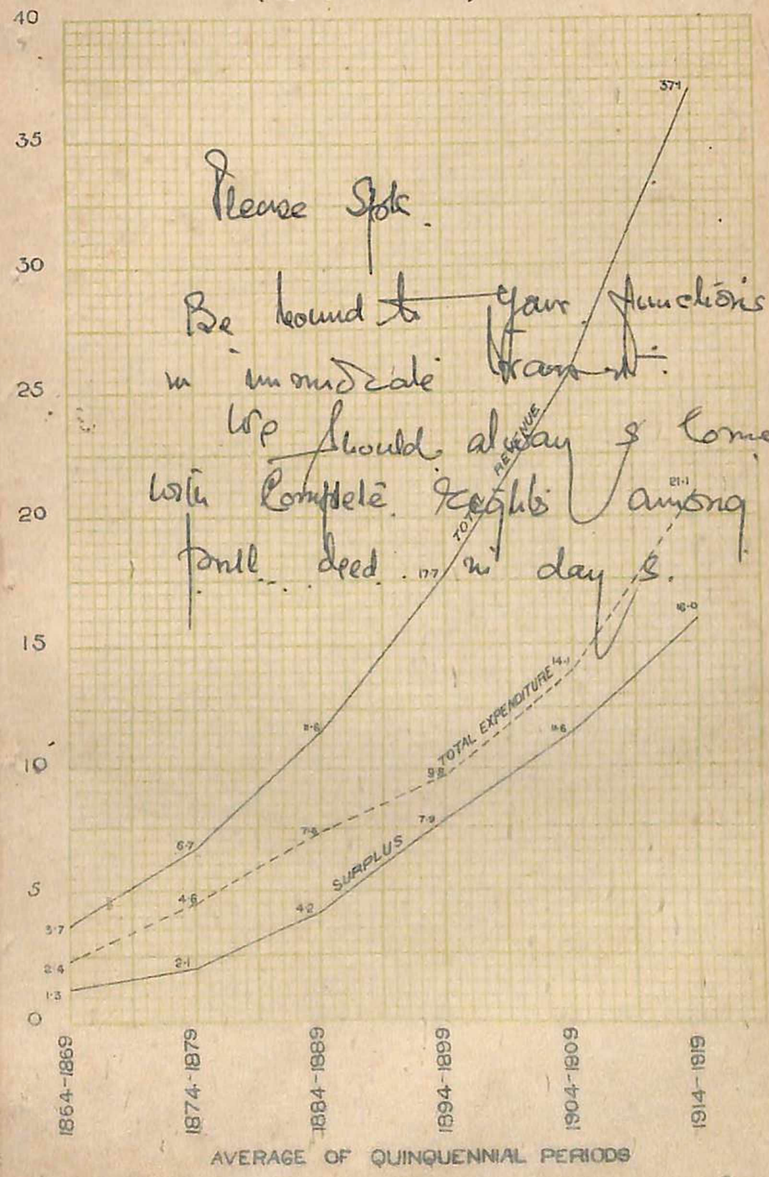

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opening up of hitherto inaccessible areas by improved communications. Forests have been opened up by networks of roads, by tramways and other mechanical means of export, and the increase in surplus is all the more satisfactory when it is considered that up to a year or two ago all the capital expenditure necessary had been met from current revenues and unlike railways, canals, or other sources of revenues to Government, the forests of India had added nothing to the debt of the country, or been financed by loans.

An additional cause for the steadily increasing revenues from forest sources has been the results of research and experiments, which by evolving new methods of concentrated working, and by exploring new uses for forest products, have had in the past, and will have to an ever-increasing extent in the future, a considerable effect on forest revenues. This aspect is dealt with in greater detail in subsequent chapters, but as an illustration the resin industry may be quoted, which, largely as the result of continuous research and experiment, has developed in twenty years from nothing to an industry bringing in 1·2 million rupees revenue yearly.

It has taken over fifty years to build up the forest estate as it now exists. From now onwards with the increase in growth of trees and improvement in quality, the closer utilization of the produce and the cheapening of exploitation the surplus should under wise management continue to increase. The foundations have been well and truly laid, the building of the superstructure yet remains to be completed.

CHAPTER III

FORESTS AND AGRICULTURE

AN overwhelming proportion of the population of India is dependent on agriculture for its maintenance, and one of the most important aspects of forest management is to meet the requirements of the agricultural population. 'Among the peasant's greatest needs are firewood to replace manure, small timber for houses and wood for implements, as well as grazing and fodder for his cattle. It has been recognized with increasing clearness that forestry has an important vocation as the handmaid of agriculture.'[1] The importance of this aspect of forestry naturally varies considerably in different Provinces. In areas of comparatively sparse population and extensive forests, such as parts of Burma, Assam or the Western Ghats, the pressure on the forests is almost negligible, and the requirements of agriculture are limited and met with ease. But in other areas, notably in parts of the Himalayas, in Kumaon and the Punjab, in parts of the Central Provinces and the Deccan, and elsewhere, the absolute possibility and existence of agriculture is intimately dependent on an adequate forest area in the vicinity; the comparatively poor and infertile soils cannot produce sufficient crops to support the population, who are compelled to eke out their precarious existence by heavy manuring with forest humus, or by trading in cattle, sheep, or goats who graze and multiply in and through the forest, or by earning wages in forest industries or by other means. And as the population increases the pressure and demand on the existing forest areas also rapidly increases, and a perpetual

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[1] Resolution by the U.P. Government on afforestation work in the Gangetic plains.

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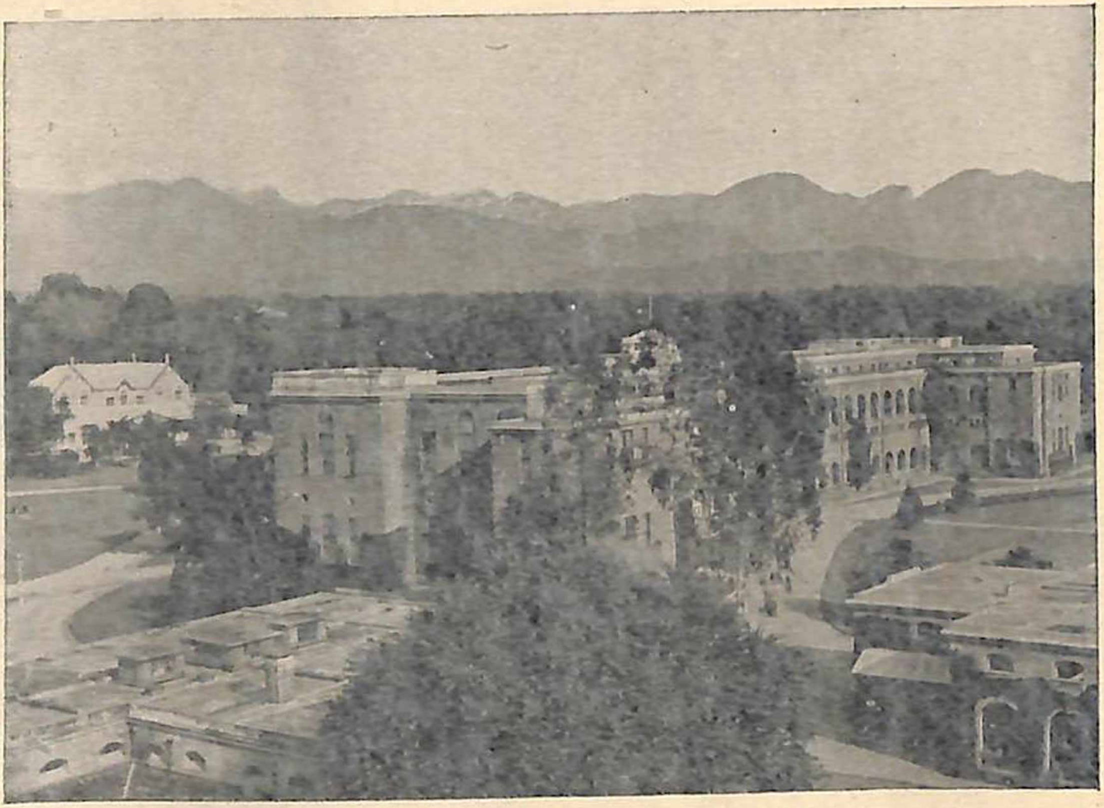

The Forest Research Institute, Dehra Dun.

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struggle results in trying to meet the urgent needs of the surrounding villagers and in trying to keep in existence an adequate area of forest to meet future needs. And in other areas again, notably in those less fertile parts of the densely populated plains of the United Provinces and the Punjab, where cultivation is somewhat precarious and where forest lands no longer exist, the pitiable economic condition of the people, the miserable mud hovels in which they live, the debased breed of half-starved cattle which they possess, the consumption of stable manure as fuel instead of as manure for enriching their fields, these and other unfortunate results must to some extent at least be ascribed to the complete absence of forest in the vicinity, and to the fact that the purchase price of essential forest products is thereby raised beyond the reach of the inhabitants.

In the legal process of reservation of Government forests and waste lands, the chief and most arduous duty of the reservation or settlement officer is the recording of claims of all the surrounding villages for forest produce, for timber, fuel, grass and grazing, leaf litter and humus, for rights of water and rights of way, for bamboos and edible fruits, and a score of other requirements. And when the settlement officer has passed final orders allowing all legitimate claims for the bonafide and agricultural use of right-holding and concessionist villages, these demands have the first claim on the produce of the forest area, even up to the maximum of output of the area, and as such rights and concessions are usually supplied free (but occasionally at reduced rates), it frequently happens that blocks of Government forest are managed entirely for the benefit of the adjoining villages, without hope or expectation of any direct profit or commercial exploitation. A few figures may be cited to illustrate how intimately the well-being of the agricultural and village populations of India are bound up with the forests. (Figures given below refer to British India only, excluding Native States, and for the year 1920-21.) Total animals permitted to graze in Government forests were 12 millions of which 2·8 millions paid fees (even full grazing fees are almost nominal, varying generally from 2 annas to Rs. 2 per annum per animal), 3·7 millions grazed at half rates, and 5·5 millions grazed free. The value of free grazing and fodder grass is put at 3·8 million rupees.

Right holders and concessionist villages were given free of cost about five million cubic feet of timber and seventy-six million cubic feet of firewood, while the value of a hundred other forms of minor forest produce, such as edible fruits and flowers, fibres for ropes, grass for thatching, bamboos, gum, resins, dye and tan materials, etc., etc., is put at one million rupees, although this is probably far below the real value, since no accurate record is kept of these petty demands. The total value of rights and concessions given away to villagers every year from the forests of British India under the control of the Forest Department must be put at nearly £1,000,000 sterling, despite the extremely low rates at which these concessions are rated. This is an item which never appears in the statistics of financial results of the working of Indian forests. Admittedly a certain proportion of this produce has no commercial or sale value, i.e., it could not be sold elsewhere if the adjoining villages were not in existence, but on the other hand the actual value to the villages, to whom the produce is given, is incalculable, since in many cases the very existence and economic life of the village is so intimately connected with the assistance to its life and agriculture provided directly or indirectly by the adjoining forests.

The importance of forests in supplying grazing and grass for cattle kept for manure and for ploughing has been mentioned above, but two further points must be emphasized. An important article of food both for the agricultural and urban population is *ghi* or clarified butter, and the *ghi* industry is very closely connected with adequate grazing grounds within the borders of the Government forests. For example in the moist Tarai tracts along the submontane belt at the foot of the Himalayas, great herds of buffaloes are kept, which roam over the extensive areas of grass lands, and it is on the existence of this never failing supply of grass and fodder that the extensive export of *ghi* from the submontane belt to the crowded cities of the plains depends. From these same areas also a steady stream of young buffaloes and cattle are exported to supplement the agricultural resources of the adjoining districts to a distance of two hundred miles or more, and the support of this cattle breeding industry is a further important function of the Indian forests. India is unfortunately and periodically afflicted with a failure of the monsoon rains, and in these years of famine, when the food and fodder crops fail and the very indifferent village grazing grounds fail to produce grass, it is a piteous sight to see the starving cattle wandering forlornly over the burnt up plains or lying down by the wayside to die, with the vultures gathering to their ill-omened meal. It is then that the forest areas are heavily tapped to supply vast quantities of fodder grasses which are exported to the famine stricken districts. The importance of these practically inexhaustible reserve supplies of fodder in times of famine cannot be exaggerated. To the poor peasant the loss of his cattle by hunger and famine is an overwhelming blow, for without cattle he can neither plough nor manure, and even if he can raise the money by loan or mortgage to buy a fresh supply, after a bad fodder famine there are not sufficient cattle surviving to meet the demand. In the famine of 1918-19, in one part of one district of the United Provinces (in the Bah Tahsil of Agra), an inaccessible and inhospitable tract of barren and broken ravines, no less than 200,000 cattle of the agricultural classes were lost. There can be no doubt that the mortality amongst the cattle would be far greater in every serious fodder famine than it actually is, but for the reserve supplies of fodder available in the forests; and these fodder reserves in the forests of the United Provinces, the Central Provinces, Central India, the Bombay Deccan, parts of Madras and elsewhere are a very important economic asset in India's forest wealth. It may be noted also that during the war, 50,000 tons of fodder grasses were collected in 1917-18 from Indian forests, to help the military operations in Egypt and Iraq.

In times of famine and food shortage also, the edible fruits and roots and flowers that are available in forest tracts, and that help to eke out the inadequate food stocks of the people, are worthy of brief mention. There is another aspect of importance connected with forests in the general economy of the rural population. In all civilized countries of the world which work their forests intensively, the wages bill on the exploitation of forests and on forest industries is a big item, and as typified in many parts of America may be the dominant factor in the prosperity of whole districts. In India perhaps more than in most countries we find this to be the case, partly perhaps because the Indian population is so predominantly agricultural, and forest works can fit in so well with the slack periods in agriculture, partly because the relatively low standard of life and rate of wages has militated against the introduction of mechanical appliances, and the working of Indian forests usually makes a far higher demand for units of manual labour than corresponding work in other countries. To give one small illustration of this aspect; in the pine forests of Kumaon, the amount of money distributed every year amongst the local hillmen for the collection and export of crude resin (to feed the turpentine and resin distilleries) exceeds three lakhs of rupees (£20,000). This is not a very vast sum by the standards of international finance, but represents an asset of very considerable importance to the poor peasants of that tract, and in excess of the whole land revenue (or land tax) of the district where the resin collection is carried out. But in India, the influence of wages paid for forest exploitation usually spreads far beyond the confines or vicinity of the forests themselves. All the major tracts of primeval or virgin forest are necessarily largely uninhabited or very sparsely inhabited (their present existence is in fact due to their uninhabited nature), and very often the labour gangs required for their working have to be brought from far afield. To quote again an example from the submontane forest at the foot of the Himalayas, every railway and road is blocked biennially with sawyers, carters, carriers and every form of labour, first in their migration to the forests after the winter crops are sown in November, and again in their migration back to their homes in time for the harvest at the end of March. From the hills they come, from the far away plains of the Punjab and the Ganges, and convert the great forests for a few months into a scene of intense bustle and activity and then again depart leaving the forests to the lonely firewatcher and the roaming tiger, but the wages they have earned go with them to be spent in marriage festivals or to be converted into gold and silver trinkets. Again the great forests of the Andaman Islands have to be worked entirely by imported labour, partly by the involuntary labour of the convict gangs of that great penal settlement, and latterly to some extent by Kachins from far away Burma. There is no use in multiplying examples, it is a feature common to most Indian forests, the great influx of labour working furiously for a while to render available for the industrial life of the country the valuable products of the forests, and then departing with their well-earned wages with the ripening of the fields to harvest, or when the terrific heats of summer or the tropical rains of the monsoon render further jungle work impossible.

Taking India as a whole, the proportion of forest land to total area (i.e., 25 per cent.) is ample, but as has been indicated already, the distribution of forests is irregular, and while some provinces such as Burma and Assam have more forests than they require or can work intensively, in other parts of India, and notably in the Gangetic plain and in the Punjab, the area of forests is quite inadequate, and the rural population has to a considerable extent to carry on as best it can without forests. At the same time there are extensive areas of waste land which by skilful management are capable of being made into successful plantations, for the production of small timber, firewood, grass, etc., which have the double advantage of ameliorating the agricultural conditions of these treeless tracts and of putting to a profitable economic use lands which are otherwise barren and valueless. In a consideration of India's forest wealth, a brief account must be given of the very successful plantations which have been, and are being, created in certain parts of India where the demand for forest produce is keen, and where there are no natural forests to meet the demand. The best known examples which will be briefly described are:—(1) The *babul* (*Acacia arabica*) and *sissu* (*Dalbergia sissu*) plantations of the Jumna and Chambal ravines in the United Provinces; (2) the irrigated *sissu* and mulberry (*Morus alba*) plantations of Changa Manga near Lahore in the Punjab; (3) the Eucalyptus (*E. globulus*) plantations of the Nilgiris near Ootacamund in Madras.

1. AFFORESTATION ON THE JUMNA AND CHAMBAL RAVINE TRACTS OF THE UNITED PROVINCES.

A common characteristic of most rivers flowing through the soft alluvium of the Gangetic plain, whose beds are appreciably below the level of the surrounding country, is a border zone or network of ravines over which the cattle, sheep, goats, donkeys, and other animals of the adjoining villages perpetually wander in search of grazing, and which have been created by the action of rainwater rushing down the bare denuded and trampled slopes into the river. In the case of two important tributaries of the Ganges, i.e., the Jumna and Chambal rivers, whose beds lie a hundred feet or more below the general level of the surrounding plain, these eroded ravines have in the course of centuries grown to enormous proportions, and are continually eating away into the cultivated lands at their sources. They are characterized by a stunted and scattered desert flora of inedible thorns and shrubs, such as *Capparis aphylla*, *Acacia leucophloea*, etc.; they have practically no economic value whatsoever; and the total area of these desert-like and inhospitable ravines in the United Provinces probably lies between half a million and a million acres. The agriculture of these tracts is very precarious, irrigation is impossible, and they are liable to frequent and intolerable famines, especially fodder famines, while the broken tangle of precipitous ravines makes the transport of large quantities of fodder from

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other parts almost impossible and anyhow extremely expensive. The possibility of putting these ravine deserts to some economic use was first considered many years ago, and they were the subject of a report in 1879, by Brandis (then Inspector-General of Forests). Spasmodic experiments with varying success were carried out in 1884 and in 1904, but the subject was not tackled in earnest until 1912, when Sir John Hewett, M.P. (then Lieutenant Governor of the United Provinces) issued an important resolution on the subject of afforestation of these denuded areas and the establishment of fuel and fodder reserves. This resolution inaugurated a strong and active policy on afforestation, and during the next five years, under the control of Sir Peter Clutterbuck (now Inspector-General of Forests) and with the active assistance of Col. Neville, the District Magistrate of Etawah, roughly 30,000 acres of waste lands were taken up with a view to their afforestation, and a series of experiments were commenced to ascertain the best methods of treatment of these areas. These experiments conclusively proved that the whole secret of success lay in the retention of the monsoon rains, combined with dry farming and weeding of young seedlings and plants. In the untreated ravines, at the end of the monsoon rains, measurements showed that the moisture had penetrated a bare six inches, while in areas treated with an elaborate system of breaking up of the surface soil, making small ridges and ditches and dams, moisture penetrated to 4 feet depth in the first year and to 9 feet depth in the second year, and resulted in a most luxuriant growth of valuable tree seedlings and fodder grasses, which automatically stopped further erosion. The results obtained have surpassed all expectations. In some of the more fertile patches, *sissu* (*Dalbergia sissu*) plants have attained 50 feet height in the six years from sowing; *babul* (*Acacia arabica*) seedlings reach 4 and 5 feet height in four months; in 1922 a thousand tons of good fodder grasses were obtained from about 5,000 acres of plantations. The ever-growing islands of vivid green and flourishing plantations in a sea of barren and aching desert afford as striking a contrast as can be found, and Mr. Hole (late Imperial Forest Botanist) noted that he considered these plantations to be the most important and successful afforestation work at present being done in India.

By March 1925 (i.e. twelve years from the date of starting the original experiments, and including five years which were largely experimental), over 13,000 acres had been successfully afforested, a further 2,000 acres of soil preparation had been completed and were awaiting the break of the monsoon rains, and the organization was complete for increasing the plantation acres by 2,500 acres yearly. The three principal advantages of these areas are (1) complete check of further erosion in the areas treated; (2) production of valuable timber, of tanbark, of firewood and wood for agricultural uses; (3) production of large quantities of fodder grasses, useful at all times to the surrounding villages but absolutely invaluable in times of fodder famine. One of the most hopeful signs at the present time is the interest that is being taken by surrounding large landowners who own extensive tracts of ravines and waste lands, and in several important cases the landowners after seeing the results obtained, have already commenced operations on similar lines on their own estates and with their own funds. It is not too much to say that the enormous and at present profitless areas available for treatment, and the enormous potential demand for the produce grown, supply the primary conditions for an almost unlimited extension of a work, which will have a profound effect in ameliorating the conditions of agriculture and the economic life of the people in those very parts of the province where the conditions of life are at present most precarious.

As regards the financial aspect of these ravine plantations, it is too early yet to write definitely. The initial cost of creation is high (from Rs. 50 to 60 per acre), but the cost of subsequent tending and upkeep is low. There can be no doubt that Government will obtain a very fair rate of interest on the money invested, and the indirect benefits cited above, the prevention of erosion, the insurance against fodder famines, and the amelioration of the conditions of agriculture, completely justify the large scale operations which have been taken in hand.

2. IRRIGATED PLANTATIONS IN THE PUNJAB.

In the Punjab plains there are very extensive areas of dry scrub jungle (called *rakhs*), with *Capparis aphylla*, *Salvadora oleoides* and *Prosopis spicigera* as the commonest species, which in their natural state are of very low economic value, but certain areas by means of irrigation have been made to produce flourishing plantations of *sissu* (*Dalbergia sissu*) and mulberry (*Morus alba*) yielding a high out-turn of fuel and a fair quantity of timber. A lucid account of the method of creation and treatment of these irrigated plantations is given in Troup's *Silviculture of Indian Trees*, Volume I, from which the following details have been taken.

In contrast with the ravine plantations of the United Provinces, which depend entirely on the rainfall for adequate moisture, irrigation by inundation canals is the dominating factor in the Punjab plantations, and the size of plantation is limited to the area which can be irrigated successfully during April, May and June, when if flooding is not carried out failure is certain. It is however a recognized principle that field cultivation has prior claim to the available water supplies, so that the plantations do not always receive as much as they should. The preliminary work of laying out an irrigated plantation is carried out by the Irrigation Department, which constructs the distributary water channels. The soil excavated from the small irrigation trenches is thrown up in the form of a ridge running alongside and *sissu* and mulberry seed is sown on this ridge, and the trenches are filled with water several times during the dry period, April to June. As the plantation becomes older less water is required, but irrigation can never be suspended altogether as the trees invariably die off.

The oldest of the Punjab plantations is that of Changa Manga near Lahore. Originally an area of 780 acres was taken up in 1866, but large extensions have been made subsequently, and the total wooded area of this famous plantation now exceeds 9,000 acres. Other irrigated plantations have been commenced in the Punjab in recent years, and by 1935 it is hoped that approximately 60,000 acres in all will have been created in various parts of the Province. The financial and economic effect of such an extensive area of flourishing plantations will be very considerable. The figures of actual growth in Changa Manga plantation show that the quantity of timber and fuel produced per acre per annum varies from 75 to 150 cubic feet in the first rotation, and increases in the second rotation (when growth is chiefly from coppice) to a maximum of over 250 cubic feet. In course of time therefore, these irrigated plantations of the Punjab may be expected to supply from 6 to 8 million cubic feet of timber and fuel annually, in districts where the present supplies are extremely meagre or practically negligible. The nett surplus (of receipts over expenditure) in the favourably situated Changa Manga plantation is at the present time about ¼ of a million rupees annually, or nearly Rs. 30 (£2) per acre per annum. It should also be mentioned that the cost of creating these large extensions is practically negligible. Unlike the Jumna ravine plantations (where the land is valueless for agriculture), the land of the Punjab plantations has a great potential value directly water is available, and until the land is actually taken up for afforestation, it is let out on rental to cultivators, and this rental more than pays for the whole cost of creation. It will thus be seen that the combined energies of the Irrigation and Forest Departments are creating very valuable estates, which will be a constant help to agriculture and industries, as well as a handsome asset to the revenue of the Province.

3. THE EUCALYPTUS PLANTATIONS IN THE NILGIRIS.

These may be briefly referred to. Started half a century or so ago to meet a chronic shortage of firewood and small poles in the hill station of Ootacamund and adjoining district, they have proved so successful that the supply has now outrun the demand. These plantations of *Eucalyptus globulus* are generally managed as simple coppice, and show a more rapid rate of growth and a larger volume production per acre than any other forests in India, possibly even in the world. Troup has recorded that a 25 year old coppice area will be 85 feet high, over 2 feet girth, and contain 14,000 solid cubic feet of timber and fuel per acre, giving a mean volume production of 576 cubic feet solid per acre per annum. A plantation 49 years old averaged 175 feet height and 6′ 9″ girth. With such phenomenal growth exhibited, it is not surprising that the price of firewood in and around Ootacamund is much lower than in any other hill station in India.

CHAPTER IV

THE FORESTS OF INDIA

MORE than one-fifth of the total area of British India or approximately 250,000 square miles is under the control of the Forest Department; of this large total however, only about 106,000 square miles are dedicated to timber production and only 70,000 square miles are under regular, or intensive management.[1] Throughout this vast forest area, scattered over the length and breadth of India from the Himalayan snows to Cape Comorin and from the arid juniper tracts of Baluchistan to the eastern limits of the Shan States, there is as may be imagined, an infinite variety in the types of forest vegetation, depending on variations of climate and soil and on other local factors. Broadly speaking, the following main types of forest may be distinguished :—

(1) *Arid-country forests*, extending over Sind, a considerable portion of Rajputana, part of Baluchistan and the south of the Punjab, in dry tracts where the rainfall is less than 20 inches. The number of species is few, the most important tree being the *babul* or *kikar* (*Acacia arabica*), which, however, in the driest regions exists only by the aid of river inundations.

(2) *Deciduous forests*, in which most of the trees are leafless for a portion of the year. These forests, which extend over large areas in the sub-Himalayan tract, the Peninsula of India and Burma, are among the most important, comprising as they do the greater part of the teak and *sal* forests.

(3) *Evergreen forests*.—These occur in regions of very heavy rainfall, such as the West coast of the Penin-

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[1] *Work of the Forest Department in India*, 1920.

sula, the Eastern sub-Himalayan tract, and the moister parts of Burma, and are characterized by the great variety and luxuriance of their vegetation.

(4) *Hill forests.*—In these the vegetation varies considerably according to elevation and rainfall. In the Eastern Himalaya, Assam and Burma, the hill forests are characterized by various oaks, magnolias and laurels, while in Assam and Burma the Khasia pine (*Pinus Khasya*) grows gregariously at elevations of 3,000 to 7,000 feet. In the North-Western Himalaya the chief timber tree is the deodar (*Cedrus Deodara*) which occurs most commonly at elevations of 6,000 to 8,000 feet, and in association with oaks or blue pine (*Pinus excelsa*); towards its upper limit the deodar merges into very large areas of spruce and silver fir, while below it are found extensive forests of the long-needled pine (*Pinus longifolia*), which is tapped for resin.

(5) *Littoral forests.*—These occur on the sea coast and along tidal creeks. The most characteristic trees belong to the mangrove family (*Rhizophoreæ*). Behind the mangrove belt is an important type of forest occasionally inundated by high tides, in which the most valuable species is the *sundri* (*Heritiera Fomes*).

The number of individual species of trees comprising the vast forest wealth of India is very considerable. The total number of woody species in India, including exotics, is about five thousand, of which rather more than half are trees, the remainder being shrubs and climbers. There are several hundred economically useful species, a few of the most important of which are dealt with in this and the following chapters. Troup has given a somewhat more detailed classification of the different types of Indian forests, and he recognizes twelve different geographical regions determined as far as possible by the character of the forest flora. Troup's classification is as follows:—(1) the Western Himalayan region; (2) the Eastern Himalayan region; (3) the trans-Indus region; (4) the North-Western dry region; (5) the Gangetic plain; (6) the West Coast region; (7) the Central Indian region; (8) the Deccan and Carnatic; (9) Assam; (10) Chittagong and Arakan; (11) Burma; (12) the

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Andamans. For a description of these different regions of forest growth, reference may be made to Troup's book *Silviculture of Indian Trees*. But in a study of the wealth of India's forests, it is simpler to describe them, not according to their types or characteristics, but according to their economic zones. India can conveniently be divided into eight economic zones, based chiefly on the markets or centres of consumption, as follows :—

Market	Province	Forest types and regions (Troup's classifications)
1. Punjab, Rajputana and frontier tracts.	Punjab, Kashmir, North-Western Frontier Province. Baluchistan.	Western Himalaya and Kashmir. Trans-Indus. North-Western dry region.
2. Upper Gangetic plain.	United Provinces. Nepal.	Western Himalaya (sub-montane). Oudh (Gangetic plain). Bundelkhand.
3. Lower Gangetic plain, Calcutta and export.	Assam. Bengal.	Eastern Himalaya. Sunderbans. Assam. Chittagong and Arakan.
4. Central India and Calcutta.	Central India States and Orissa. Central Provinces.	Central India.
5. Bombay, the Deccan and export.	Bombay Presidency, parts of Central India States, Baroda, Guzarat and West Coast.	West Coast region. Central India.

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6. Madras, South India and export.	Parts of Central India and Madras, Mysore, Coorg and South Indian States.	Deccan and Carnatic. Central India region. East Coast.
7. Burma and export.	Burma.	Burma.
8. Calcutta and export.	Andamans.	Andamans.

In the description given below of these different zones and markets, the descriptions of forest types and the utilization of the forest products will to a great extent apply equally to the forests under the Government of India and the Forest Department, and to the forests of the self-ruling Indian States, but the actual figures given of forest areas, quantity, and value of forest products utilized, etc., will, generally speaking, refer only to the former forests, since it is frequently quite impossible to obtain any adequate or reliable information regarding the forests of Indian States.

It must be emphasized also that India is a vast subcontinent with a greater range of those conditions (climate, rainfall, altitude, soil, etc.) which tend to produce variations in forest types than almost any other country in the world, and in the brief review of forest conditions which is here attempted, it has only been possible to describe in the most general terms the enormous variations of forest growth that occur, and the wide range of conditions of demand, accessibility, possibilities of exploitation, and all the factors that have a deciding influence on the commercial value of a forest.

1. THE PUNJAB AND FRONTIER TRACTS

SECTION I.—*Timber*

Economically and from the timber production point of view, easily the most important forests of this zone are

13130

the extensive coniferous forests of the Himalayas, which will be considered first. (In this note the coniferous forests of the U.P. are included, as the timber from these forests is taken chiefly to supply the markets of the Punjab and Rajputana.) The following are the most important species of trees :—

(1) *Cedrus deodara.*
(2) *Pinus excelsa.*
(3) *Pinus longifolia.*
(4) *Picea morinda.*
(5) *Abies Pindrow.*
(6) *Pinus Gerardiana.*

(1) *Cedrus deodara.*—The deodar. Its timber is better than that of the other conifers and is very durable. The heartwood is not usually eaten by white ants, but the sapwood is readily attacked. The principal use is for railway sleepers which last about 12 years on the average. From the wood an oil is extracted by destructive distillation. It is used for preserving the inflated skins used on the main Punjab rivers.

(2) *Pinus excelsa.*—The timber is good, the sapwood white, the heartwood red. Of the common conifers it comes after deodar and for interior work such as planking and furniture is preferable to deodar as it is not so oily. The resin yields a better quality of turpentine than *chir* resin, but has so far only been extracted experimentally.

(3) *Pinus longifolia.*—The *chir.* The sapwood is white and the heartwood pale reddish brown. It is a rough coarse timber and not durable, but being available in large quantity is much used. It yields a valuable resin, which will be described in detail in the chapter on minor forest produce.

(4) *Picea morinda or Smithiana.*—The spruce. The tree grows to an enormous size, frequently reaching 150 feet height and 10 feet girth, while one of 215 feet height and 23 feet girth has been measured. Wood is white, soft and evengrained with occasionally a brown tinge in the centre of the old trees, but there is no heartwood. White ants eat it. The brown timber is said by

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Plate IV.

Deodar forest in the Punjab : the sacred tree of the Himalayas.

contractors not to float but experiments in floating sawn specimens in a tank showed that the brown timber floats as well as the white. The experiment, however, is inconclusive.

(5) *Abies Pindrow.*—The silver fir. The timber is very similar to that of the spruce, but on the whole is not quite so good, and large trees are usually hollow. A height of 206 feet and girth of 26 feet has been measured.

(6) *Pinus Gerardiana.*—The wood is hard, tough and very resinous, but is scarcely ever used. The main value of the tree lies in the seeds which are collected and eaten, and are exported to the plains mainly from trans-Indus.

[1] Taking all the above conifers together, the first fact that strikes one is that the total workable area is 8,650 square miles (say 5½ million acres). This is not a very vast figure when one thinks of the 200 million acres of pine forest in British Columbia or the 90 million acres in the province of Ontario, and strong justification will be required before embarking upon new industrial enterprises which make huge inroads into forest supplies, as for instance pulping. Nevertheless the Indian area without great developments in forest working can yield about 23¼ million cubic feet of timber annually (say 460,000 tons). Of this 8,650 square miles of forest, only one-third is under the direct control of the Forest Department, while two-thirds belong to Indian States, whose rulers are generally very much alive to the value of their forest properties. To come to details:

In regard to the silver fir and spruce forests the total workable area, as far as present information goes, can be put at 2,920 square miles (say 1,860,000 acres). That is, it represents about one-third of the whole area under review. The Punjab Forest Department controls 764 square miles, Punjab Indian States 1,959 square miles, U.P. Forest Department 37 square miles and U.P. Indian States 160 square miles.

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[1] *Data* taken from Gibson's note published in *The Indian Forester*.

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The timber trade does not differentiate at all closely between fir and spruce timber. The present supply of both species is approximately 1¾ million cubic feet (35,000 tons), Wazirabad on the Chenab river being the biggest centre of supply with Jhelum a close second.

These fir and spruce forests are practically virgin forests and can yield close on seven million cubic feet of timber a year without any great forest developments.

From the least worked coniferous forest of the North-West Himalayas one has next to turn to the heaviest worked, namely, the deodar area. In this category one has to include a comparatively small tract of *devidiar* (*Cupressus torulosa*) forest as the timber trade does not scruple to sell the latter as deodar. The workable area of deodar forest in the North-West Himalayas is 2,010 square miles (say 1,280,000 acres) and the current annual receipts in timber depots of deodar timber is just over five million cubic feet (100,000 tons), which can be raised to six million cubic feet as soon as more intensive management is introduced.

As in the case of the spruce and silver fir forests the greater part of the deodar zone lies within Indian States, mainly in the Punjab. The Punjab Forest Department only controls 158 square miles and the U.P. Forest Department 90 square miles, the remaining 1,762 square miles being State forests, of which 50 square miles lie in the United Provinces.

The next conifer to be considered is the blue pine. It grows pure over large areas, but often in admixture with the deodar, so the determination of its area is a little difficult. Besides it is spreading very rapidly as the result of systematic protection mainly from fire, so much so that blank areas and bare hillsides of fifteen and twenty years ago are now covered with dense crops of saplings. Perhaps no timber has found favour in the timber trade as fast as the blue pine. Next to worthless in 1895 it now fetches two-thirds the price of deodar. Added to that one has to note exceptionally fast height growth, often 4 feet a year, and rapid radial growth, five or six rings per radial inch. The working of *Pinus excelsa* intensively on a rotation of eighty years can be foreseen and thus it becomes a very valuable source of coniferous timber supply.

The workable area is not large at present, 993 square miles (say 635,000 acres) mostly in Indian States, viz., 654 square miles, all in the Punjab, according to present available information. The Punjab Forest Department controls 287 square miles and the U.P. Forest Department 52 square miles. The annual supply of timber of this species reaching the timber markets is already 2¾ million cubic feet (55,000 tons). An early increase to 4¼ million cubic feet is probable.

The last belt of forest and also the second most extensive, is that covered by the *chil* or *chir* pine, *P. longifolia*. This species has already been closely studied and Troup's excellent forest memoir on *P. longifolia* is a model of its kind and the precursor, it is hoped, of equally good studies on the other principal timber trees of India.

The workable area of *chir* pine is about 2,709 square miles (say 1,730,000 acres), fairly equally divided between the Punjab and U.P., as the following figures will show:—

	Square miles.
Area under Punjab Forest Department.	254
Area in Punjab States	1,082
Area under U.P. Forest Department ...	1,203
Area in U.P. States	170

P. longifolia timber is probably the strongest Indian coniferous timber and may aptly be named the 'Indian Oregon Pine'. It has a ready and rapidly expanding market, 4¼ million cubic feet being the present approximately annual supply, or 85,000 tons, a yield which can be raised to 6 million cubic feet.

This brief review indicates the great potential wealth of timber output from the coniferous forest of the Himalayas. The output is almost entirely consumed in the Punjab and Rajputana, the great length of lead by rail to seaports making export to Europe practically impossible.

In the Himalayas there also occur extensive forests of oaks mixed with rhododendrons, chestnuts, maples, and other broad-leaved species, several of which are of potential economic importance (e.g., the oaks for tannin extracts and barrel staves, etc.) but the cost of extraction to the plains is generally prohibitive, and these extensive forests have little actual value at present except in the neighbourhood of hill stations, where a demand for firewood and charcoal exists, and locally for meeting the requirements of leaf fodder and agricultural implements of the villagers. The walnut is however of importance, both for its valuable timber and to some extent for its fruit.

In the trans-Indus region the Himalayan conifers steadily decrease with the decreasing rainfall, and in Baluchistan with an annual rainfall of 12 inches or less, the principal conifer is *Juniperus macropoda*, which forms somewhat open forests but gives an excellent timber for pencils and other uses. The forests of the plains (locally called *rakhs*) are the poorest in vegetation owing to the arid climate and semi-desert conditions. In the extreme north of this region, on the elevated plateaux between the Jhelum and the Indus, the dominant species are *Acacia modesta*, and *Olea cuspidata*. On proceeding south, vegetation diminishes towards the desert regions of the Southern Punjab, Sind and Rajputana, and practically disappears in the driest parts. The species of principal economic importance along the rivers in Sind is the *babul* or *kikar* (*Acacia arabica*), a species whose timber is hard and excellent for a large variety of uses, and whose bark is one of the principal tannin materials in India. The *rakhs* of the Punjab consists of scattered stunted trees and shrubs of such species as *Prosopis spicigera*, *Salvadora oleoides*, and *Capparis aphylla*, of very small commercial value, and produce only indifferent fuel and camel grazing. The great extension of irrigated cultivation in the Punjab has been almost entirely at the expense of the *rakhs*, and the time is fast approaching when none of them will be left in their original condition as those which have not been thrown open to cultivation are worked for firewood.

In the case of small *rakhs* surrounded by cultivation it is not uncommon to find trees such as *Acacia arabica*, *Acacia modesta*, *Morus alba* and other plants not normally found in the *rakhs* establishing themselves, owing probably to an increase in the relative humidity, rise of the subsoil water level and moderation of the hot wind brought about by irrigation and cultivation. Outside the *rakhs* in irrigated tracts the typical *rakh* plants very soon disappear and are replaced by cultivated plants such as *Acacia arabica*, *Albizzia Lebbek*, *Zizyphus jujuba*, etc. In the moister parts of the plains sub-Himalayan plants are extending their range and some of them will probably in time extend all over the irrigated portion of the plains.

The valuable Changa Manga and other irrigated plantations of the Punjab have also been, or are being, created out of the *rakhs*. Thus although the *rakhs* themselves are of small value, the advent of irrigation and canal water makes them immediately of very great value.

It is impossible to give any accurate figure of total area or of annual out-turn of the Punjab *rakhs*. Further possibilities of development and increased output depend entirely on facilities for irrigation.

SECTION II.—*Minor Forest Products*

The most important minor forest industry of this tract is the Resin Industry, which has been described and discussed elsewhere. Apart from this, the Punjab and Kashmir forests are the principal sources of supply of various herbs and shrubs such as *Podophyllum Emodi*, *Artemesia maritima*, etc., which are described in chapter V, and are of importance in the preparation and manufacture of podophyllotoxin, santonin, and similar medicines or drugs. Recently a paper mills company has been formed for making paper at Dadupur on the Western Jumna Canal, which will utilize the *baib* grass supply available in the Kalesar reserve, the Sirmoor State forests and the Kalsia State forests. The output of the mill is likely to be in the neighbourhood of 4,000 to 5,000 tons a year. The possibilities of mechanical pulp will also be investigated.

2. THE FORESTS OF THE UPPER GANGETIC PLAIN

Forests of the Sub-montane Belt, U. P. and Nepal

SECTION I.—*Timber*

The Gangetic plain is one of the most densely populated tracts in the world, from which all vestiges of the primeval forests have long since disappeared except along the unhealthy malarious strip at the foot of the Himalayas. On this narrow strip and to a certain extent on the more accessible forests of the Himalayas is thrown the enormous demand for forest products of the teeming million's of the treeless plains, and the extreme importance of these sub-montane forests in the economy of this vast community needs no emphasizing. In the United Provinces, which is typical of this zone, the actual area of reserved forest is 7,000 square miles (including 3,000 square miles in the Himalayas) or just 7 per cent. of the whole area, but of this total rather less than 3,500 square miles is valuable tree forest and intensively worked, the remainder consisting of scrub growth, grass lands and grazing grounds, barren and precipitous, mountains or inaccessible hill areas.

There are three principal types of forests of economic importance: (1) the coniferous forests of the mountains; (2) the *sal* (*Shorea robusta*) forests of the sub-montane belt; (3) the scrub forests of Bundelkhand, south of the Ganges.

(1) *The Himalayan Forests* have already been discussed in the previous section, and do not require further reference here.

(2) *The Sal Forests of the Sub-montane Belt.*—The markets of the Gangetic plain are chiefly dependent on the valuable *sal* forests which run in a narrow belt at the foot of the hills from the borders of the Punjab eastwards to Assam. The durability, strength, freedom from white ant attack, and easy seasoning of this

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Plate V.

Fine sal forest of the submontane zone.

valuable timber cause it to be intensively exploited throughout the whole range of its habitat, and on the adequate supplies of *sal* timber depend to an enormous extent the upkeep and expansion of railways, the construction of buildings in cities and villages, and in brief the continued economic prosperity of the immense population of the Gangetic Plain. The *sal* forests may be divided into three main types: (*a*) Forests on the Siwalik rock formations of the Lower Himalayas; (*b*) forests on the elevated plateaux and raised beaches of the rivers, on the gravel and boulder soil of the *Bhabar*, at the foot of the hills; (*c*) forests on the moist loamy soils of the *Tarai* zone, and on the pure alluvium of the Gangetic Plain.

(*a*) The hill forests produce the densest and most durable timber, but hollowness and dry-rot is very prevalent amongst the larger trees. These forests are always very irregular and the *sal* is usually mixed with a variety of less valuable junglewoods. Extraction from these steep and broken slopes and tangle of ridges and valleys is usually difficult and expensive, so that only the best of the timber is extracted, and large quantities of firewood and inferior timber are left to rot in the forest.

(*b*) The *Bhabar sal* forests are usually the finest in the zone of this species. The *sal* finds the optimum conditions for its development, and grows gregariously over wide stretches of country, the individual trees remaining vigorous and healthy to a large size. These *Bhabar* areas supply the bulk of the large beams and baulks of *sal* timber for which there is an incessant demand at high prices, and the best quality of *sal* railway sleepers and sawn scantlings.

(*c*) The *Tarai* and plains forests are of inferior quality as compared with the *Bhabar* areas, but are usually very favourably situated for export and demand. These favourable factors exert their maximum effect in the Gorakhpur district, where expanding cultivation has reduced a great expanse of virgin forest to an archipelago of islands of *sal* in a sea of densely populated and intensively cultivated land. Here the demand for every form of forest produce is so intense that even

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twigs and dry leaves are entirely utilized, and these forests produce a *net annual revenue of over £1,000 per square mile.* The timber supplies from several miscellaneous species play a not unimportant part in the economic development of this zone, amongst which may be mentioned:—

Sissu (*Dalbergia Sissu*), an essential timber for the furniture industry.

Haldu (*Adina cordifolia*), a valuable turnery timber.

Sain or *asaina* (*Terminalia tomentosa*).

Khair (*Acacia Catechu*), the basis of the kutch industry.

Bakli (*Anogeissus latifolia*)	Valuable timbers for agriculture, for cart-wheels and for tanning materials.
Sandan (*Ougeinia dalbergioides*)	
Babul (*Acacia arabica*)	

The total area of these submontane *sal* and miscellaneous forests (inclusive of grass and grazing lands) in the U.P. amounts to about 3,000 square miles, or 3 per cent. of the area of the densely populated tract of the Gangetic plain which it has to serve. Of this total, however, only about 1,000 square miles are valuable *sal* forests, from which in 1921-22 about five million cubic feet of timber (in addition to fuel and charcoal) were extracted.

Despite the strong demand, the economic value of this submontane belt of forest continues steadily to increase. Year by year under careful conservation the quantity of available produce continues to increase; improved methods of silvicultural management enable more concentrated working; the more distant areas are being opened up by roads and tram-line or railway extensions. During the last year or two the Nepal Durbar has made a commencement to open up the incalculable wealth of finest quality timber, locked away for centuries in the virgin forests of the Nepal foot-hills and *Bhabar* zone, which hitherto have been left in undisturbed possession of the tiger and wild elephant, and a light railway is already tapping a comparatively small section of these trackless and matchless forests, which are expected to produce several million cubic feet of timber in the next few years.

(3) *The Forests of Bundelkhand.*—These are of the

MINISTRY OF CULTURE · GOVERNMENT OF INDIA
GSL

Central India type, which is described in a later section. The poor soil and dry, hot climate results in a poor and open scrubby growth of forest, which is, however, of local importance partly for grazing, and partly because it produces small poles for agricultural requirements and the construction of huts, and also fuel and charcoal, bamboos, and fodder grasses. There is small prospect of these scrub forests becoming really valuable unless the experimental introduction of lac, now being undertaken, enables extensive areas to be treated for intensive lac cultivation. There are possibilities also in increasing the value of these forests by the introduction of more valuable species, such as teak (*Tectona grandis*) and *sissu* (*Dalbergia Sissu*) in the better localities.

SECTION II.—*Minor Forest Products*

The principal industry in the United Provinces dependent on a minor forest product is, from the forest point of view, undoubtedly the Resin industry. This has been discussed and described elsewhere. In the submontane forests, the export of *sabai* grass is carried out very extensively to feed the paper mills of Lucknow and Calcutta. There is always an intense demand for bamboos for sale in the cities and villages of the plains, and all bamboo areas in the United Provinces are thoroughly exploited. Similarly all available supplies of *khair* trees (*Acacia Catechu*) are utilized for the manufacture of *katha*, and all bark supplies of *babul* trees (*Acacia arabica*) for the big tanneries of Cawnpore. The submontane and Bundelkhand forests play an important part in supplying thatching grass, fodder grass and grazing, while immense quantities of the giant elephant grasses are available for paper production, but existing economic conditions render these at the present time unworkable.

3. THE FORESTS OF THE LOWER GANGETIC PLAIN, BENGAL, ASSAM AND CHITTAGONG

SECTION I.—*Timber and Fuel*

This zone includes the fertile and densely populated tracts of Bengal, and the great industrial city of Calcutta.

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The forests fall naturally into several distinct types and areas, which will be dealt with separately:—

(1) The submontane forests of Bengal, which are a continuation of the submontane belt of the United Provinces described above.

(2) The forests of Assam.

(3) The forests of Chittagong.

(4) The Sunderbans of the Gangetic delta (composed largely of mangrove swamps and tidal forests). These different types will be briefly described separately.

1. *The submontane forests of Bengal* coincide with what Troup has called the tropical zone of the Eastern Himalayan region, and of which he has given the following description:—

The tropical zone up to a 5,000ft. altitude begins with a forest belt stretching some distance out into the plains, and consisting of (i) *Sal* forest including the *sal* savannah tracts in which the dominant grass is *Saccharum narenga* (these *sal* forests are of great value, intensively worked, and show possibly the finest growth of the species in British India); (ii) riverain forests of *Dalbergia Sissu* and *Acacia Catechu*; (iii) mixed deciduous forests of *Terminalia spp.*, *Lagerstroemia parviflora*, *Sterculia villosa*, *Bombax malabaricum*, *Duabanga sonneratioides*, *Anthocephalus Cadamba*, *Schima Wallichii*, *Gmelina arborea*, *Cedrela Toona*, *Albizzia procera*, *Premna*, *Bauhinia*, *Stereospermum*, etc.; (iv) moist savannah forests, consisting of stretches of tall savannah grasses, of which *Saccharum procerum* and *narenga* are among the commonest, with scattered trees, among the chief of which are *Albizzia procera*, *Bombax malabaricum*, and *Bischofia javanica*; (v) evergreen forests with a large number of species, among which are *Michelia Champaca*, *Schima Wallichii*, *Artocarpus Chaplasha*, *Dillenia indica*, *Talauma Hodgsoni*, *Aesculus punduana*, *Amoora*, *Eugenia*, *Echinocarpus*, *Eurya*, *Garcinia*, *Elaeocarpus*, *Cinnamomum Cecidodaphne*, *Canarium sikkimense*, and *Ficus elastica*, the last named now rare; there are numerous canes, climbers and evergreen shrubs forming a dense impenetrable undergrowth.

In the outer hills *sal*, where present, occurs chiefly on the ridges, the intervening depressions and valleys being occupied by moist mixed forest in which the bamboo (*Dendrocalamus Hamiltonii*) is often abundant. In the upper part of this zone two characteristic trees, *Betula cylindrostachys* and *Alnus nepalensis*, make their appearance. In the neighbourhood of Darjeeling there is also a certain amount of forest of the temperate zone, ranging from 5,000 feet to 12,000 feet, where the predominant trees are oaks chestnuts, magnolias, laurels, maples, alder, birch, etc.

The approximate area of this submontane and temperate belt under the Forest Department totals 1,900 square miles, included in the forest divisions of Darjeeling, Kalimpong, Kurseong, Jalpaiguri, Buxa, and Goalpara, but of this total extensive areas are grass lands and unproductive. The figures of out-turn of timber and fuel in the year 1921-22 are given as follows :—

Quantity	Revenue received by Government
Timber, 2 million c.ft.	Rs. 10,76,000
Fuel, 8 million c.ft	

(2) *Assam.*—The Assam region outside the sub-Himalayan tract comprises the Brahmaputra and Surma Valleys, (the latter area having had much of its forest destroyed by shifting cultivation), together with the intervening hill ranges (the Garo, Khasi, and Jaintia hills) and the Naga, Manipur, and Lushai hills on the eastern and south-eastern frontiers. Over the greater part of this region the rainfall exceeds 80 inches, while Cherrapunji in the Khasi hills with a *normal* rainfall of 460 inches is one of the rainiest spots in the world. The valleys, where not under tea or agricultural crops, are clothed with expanses of tall savannah grass or with dense forest often of an evergreen type. Among the more characteristic species of the valleys and lower hills are *Mesua ferrea*, *Artocarpus Chaplasha*, *Michelia Champaca*, *Lagerstroemia Flos-Reginae*, *Amoora Wallichii*, *Vatica lanceaefolia*, *Alstonia scholaris*, *Cinnamomum Cecidodaphne*,

Dillenia indica, *Dipterocarpus pilosus*, *Chickrassia tabularis*, *Garcinia spp.*, *Eugenia spp.*, *Carallia lucida*, *Baccaurea sapida*, *Aquilaria Agallocha*, *Sterculia alata*, *Cedrela Toona*, *Gmelina arborea*, *Morus laevigata*, *Stereospermum chelonoides*, *Ficus elastica* and many other species of *Ficus*, *Terminalia citrina*, *T. Myriocarpa*, and many other trees. There are various bamboos, of which perhaps the commonest are *Melocanna bambusioides* and *Bambusa Tulda* and there is often a dense impenetrable undergrowth of canes, climbers, and evergreen shrubs. Among the more typical trees in riverain areas are *Bombax malabaricum*, *Albizzia procera*, *Bischofia javanica*, *Anthocephalus Cadamba*, *Elaeocarpus assamicus*, and *Lagerstroemia Flos-Reginae*. South of the Brahmaputra, *sal* forest occurs in the Garo hills and in the Kamrup district.

The hill forests of the Assam region approximate in type to those of the Eastern Himalayan region, except that there is no alpine zone. These hill forests may be separated broadly into evergreen broad-leaved forests and pine forests. The former include species of *Magnolia*, *Manglietia*, *Michelia*, *Acer*, *Prunus*, *Pyrus*, *Pieris ovalifolia*, *Rhododendron arboreum*, *Bucklandia populnea*, *Alnus nepalensis*, *Betula alnoides*, *Carpinus viminea*, and many species of *Quercus*. The pine forests occur at elevations of 2,500 feet and over, particularly at 4,000-4,500 feet, and are composed of the one species *Pinus Khasya*. Shifting cultivation has destroyed much of the natural forest growth on these hills. The hill-tops of the Assam region, like those of the Nilgiris, are open grasslands with trees and shrubs identical with, or closely related to, those of the Nilgiris. The mountains to the east are often covered with bamboos. The forests of Assam afford a most striking example of the effect of demand and exploitability on the commercial value of forest tracts. The local demand for forest products is very small, most of the tribes such as the Nagas, Abors, etc., are wild savages and the extensive tea gardens are practically self-supporting. Thus the commercial value of the Assam forests is mainly dependant on the possibilities of an export trade chiefly of *hollock* (*T. Myriocarpa*) *hollong* (*D. Pilosus*) and *Chickrassia* to Calcutta and

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the southern markets. The bulk of the forests are untouched by roads, some of the timber is not floatable by river, and timber cannot compete with tea for the limited transport facilities of this zone. Many of the forests are also cut off by tea gardens, whose owners do not relish the idea of heavy timber traffic cutting up their roads. Thus the exploitation of the Brahmaputra forests has to a great extent hitherto proved an insoluble problem, and enormous areas, some of them showing the most tremendous vegetative growth and the most gigantic trees in all India (e.g. the evergreen forests of the valleys and lower hills) remain unworked and at present almost valueless. The total area of reserved, protected and unclassed forests under the Assam Forest Department (excluding Goalpara division) exceeds 20,000 square miles, from which, in 1921–22, about six million cubic feet of timber and eight million cubic feet of fuel were shown as sold or utilized, but the gross revenue to Government therefrom only amounted to Rs. 5,50,000. By way of contrast it may be mentioned that seventy square miles of forest in Gorakhpur division, United Provinces, probably the most intensively managed natural forests in India, produced from the sale of timber and fuel approximately Rs. 8,00,000 in 1921-22, or over 150 per cent of the corresponding revenue from the 20,000 square miles of forests of Assam. And this enormous difference is primarily due to the difference in demand and exploitability, and proves the great importance of these factors in determining the commercial value of forests.

(3) *The Chittagong forests.*—This is another region of heavy rainfall, the *lowest* normal rainfall recorded being 100 inches. Along the coast mangrove swamps occur, while strips of *Casuarina equisetifolia* occur here and there on beaches of pure sand. The inland forests of Chittagong are worthy of special mention; up the valley of the Chittagong river there are some magnificent evergreen and moist deciduous forests, virgin and untouched by the axe, with gigantic trees of numerous valuable species, such as *Cinnamomum*, *Bischofia*, *Chickrassia*, *Mesua*, *Amoora*, *Dipterocarpus*, *Tetramels*, etc. One such area is the Ryinkaphali zone, lying in the watershed of a

tributary of the Chittagong river on the left bank. Another and still finer and larger area occupies the slopes along the Kasalong river for nearly 180 miles in length. Possibilities of cheap extraction are afforded by the splendid floating rivers and waterways, and for the heavier timbers that will not float there are unlimited quantities of bamboos (chiefly *B. Tulda* and *Melocanna*), from which rafts could be made. The great potential wealth of these tracts must in time result in their commercial exploitation.

The total area of reserved and unclassed State forests in this zone are about 1,600 and 4,000 square miles respectively, the latter at present being more or less undeveloped but of enormous potential importance. The total gross revenue received by Government for the forest products sold or removed in 1921–22 was Rs. 3,00,000, less than half of which was from the sale of timber and fuel, and a large part of the revenue obtained from this tract comes from bamboos and minor forest products.

(4) *The forests of the Sunderbans.*—Troup (*Silviculture of Indian Trees*) has given an excellent description of the forests of the Sunderbans, from which the following account is quoted. The famous Sunderbans tract of Bengal in which *sundri* (*Heritiera fomes*) is the most important species, is one of the most valuable forest estates in India; it supplies with timber, firewood and other produce not only the surrounding districts but also the town of Calcutta. This tract forms the southern portion of the Gangetic delta, bordering on the Bay of Bengal and extending 180 miles east to west and 80 miles north to south. The Government forests of this tract are confined to the Twenty-four Parganas and Khulna districts; the reserved forests comprise an area of 1,703 square miles, of which 594 square miles are water-channels, while the protected forests, portions of which have been disforested from time to time, at present comprise an area of 1,711 square miles. Apart from the Government forests there is an adjoining tract of forest in the Backerganj district in process of being cleared for cultivation.

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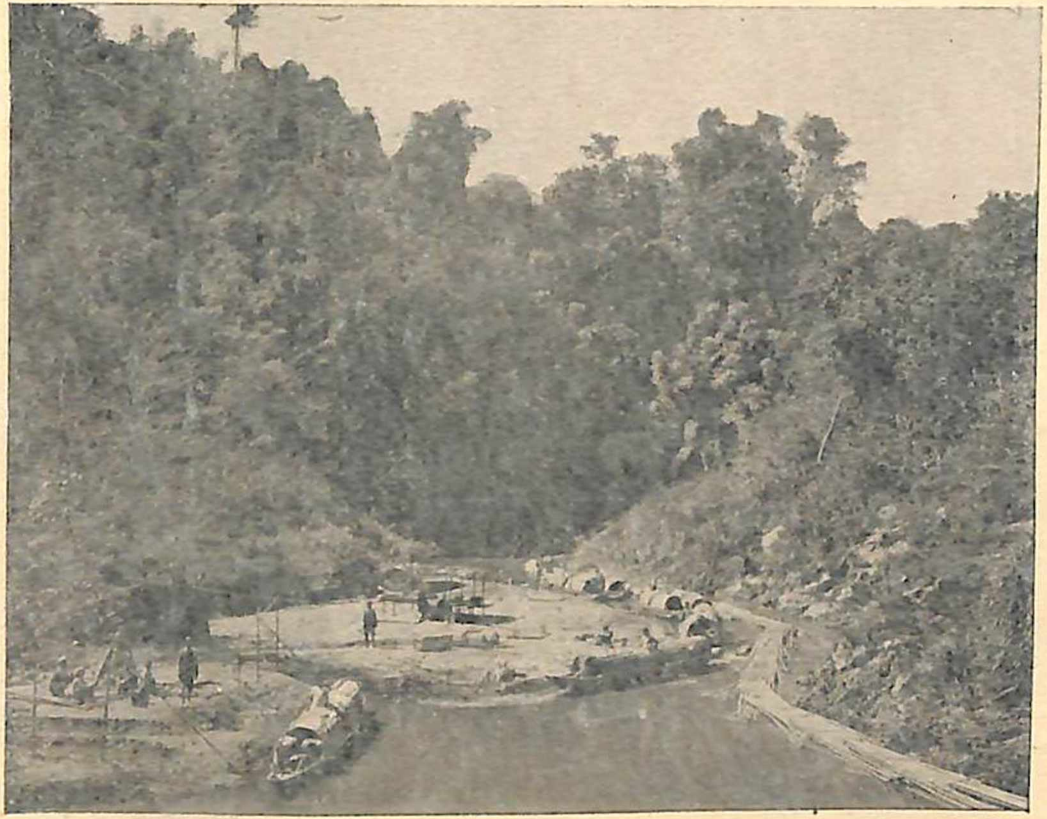
Plate VI.



Up the Kasalong river: virgin forests of the Chittagong Hill Tracts.

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The forests occupy a flat plain of recent alluvial origin, formed, and still in process of formation, by the gradual deposition of silt brought down by the Ganges and Brahmaputra rivers, and intersected by a network of rivers and channels. The larger estuaries, which run in a general north-to-south direction, are more than a mile wide where they enter the forest and three to four miles in width where they debouch into the Bay of Bengal. These estuaries or rivers are old beds of the Ganges, which has gradually trended eastwards, forming new channels, and these old beds would long since have silted up but for tidal action. Their upper reaches, traversing cultivated lands, are gradually silting up, preventing fresh water from passing down them, with the result that their lower reaches are tending to become more and more salt. Apart from the main estuaries there are innumerable side channels known as *khals*, some of which (*barani khals*) lead from estuary to estuary, and others (*mara khals*) gradually branch into smaller channels until they disappear in the forest. Many of the smaller *khals* have their origin in depressions of varying size known as *bhils*, which as a rule are not well stocked with tree growth. The *khals* are kept open by the action of the spring tides, which at high water cover the whole country to a depth of a foot or more, and in receding scour out the channels and prevent them from silting up. On cultivated lands the construction of bunds to keep out the salt water prevents this tidal action and causes the channels to silt up. During the dry season the influence of the tides is felt far up the channels, but in the rainy season tidal action is nullified by the constant stream of fresh water seawards. The *khals* are the natural highways for the extraction of forest produce, which is all brought out by boat, the tidal currents being utilized for conveying the boats in one direction or the other. The erosion which takes place along the banks of some of the larger rivers is counterbalanced by fresh deposits of alluvium in the form of low islands usually near the centre of the mouths of the estuaries. These islands or banks, locally known as *churs*, vary in composition from hard sand along the sea-face to soft mud farther inland, and frequently form barriers across the mouths of the larger rivers, especially towards the east of the Sunderbans, constituting a danger to navigation. When these banks become islands they intercept the seeds of trees and other plants carried down by water, and thus in time become covered with forest growth and merge into the forest tract as a whole. The vegetation of the Sunderbans comprises numerous species of trees, of which the principal, besides *sundri*, are *Excaecaria Agallocha*, *Sonneratia apetala*, *S. acida*, *Carapa moluccensis*, *C. obovata*, *Amoora cucullata*, *Aegiceras majus*, *Cynometra ramiflora*, *Avicennia officinalis*, and the mangroves *Ceriops Candolleana*, *C. Roxburghiana*, *Kandelia Rheedii*, *Rhizophora mucronata*, and *Bruguiera gymnorhiza*. *Pongamia glabra* is found along sand-hills near the sea, and mango, *Diospyros Embryopteris* and a few other trees occur on former village sites. It is not uncommon to find *sundri* springing up under large, dying *Sonneratia* trees, the suckers of which have become silted up. In the western or lower half of the Sunderbans there is little or no *sundri*. In the eastern half it is scarce near the sea-face except in the most easterly portions, but on proceeding inland it increases in quantity until pure or nearly pure *sundri* forests are met with. On the existence of two separate types or qualities of *sundri* forest Mr. Trafford[1] remarks: 'Observation of sample plots and measurements of trees have brought to light the existence of two types of *sundri* forest which may be described as (*a*) the salt-water type and (*b*) the fresh-water type. The former is found in the area near the sea-face and on the high ground which forms the banks of all large and medium-sized *khals* throughout the forests. The growth of the salt-water type is extremely slow, and the average figures yielded by one sample plot show that it is only 1/56 of a foot per annum. So universal is the presence of this type along the banks of streams navigable by steam launches that any one traversing the forest without going into the smaller *khals* would receive the impression that there

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[1] Working Plan for the Forests of the Sunderbans, 1911.

Plate VII.

Export of bamboos, Kasalong river, Chittagong Hill Tracts.

MINISTRY OF CULTURE · GOVERNMENT OF INDIA
GSL

are few or no good *sundri* trees in the Sunderbans. The fresh-water type of forest predominates at a distance of from one to three hundred yards from the edge of all *khals.* This forest consists of straight, tolerably tall stems from one foot to two and a half feet in girth, growing fairly compactly with little or no undergrowth and in places containing over three hundred trees per acre.' The growth of the *sundri* is best where the level of the ground is intermediate between the high strip along the *khals* and the low hill areas farthest away from them; the quality is usually also good towards the sources of the smaller *khals.* The proportion of *sundri* in the crop varies greatly, linear valuation surveys showing a variation of 1 to 240 *sundri* trees a foot and a half in girth and over per acre according to the degree to which the *sundri* is mixed with other species, or forms more or less pure crops. In dense forests of *sundri* undergrowth is practically absent, but in certain portions of the area there is an undergrowth of varying density, sometimes thick and almost impenetrable. Such areas are favourite haunts of the man-eating tigers which infest the Sunderbans.

The Sunderbans division in 1921-22 produced over 5 million cubic feet of timber and over 4 million cubic feet of fuel, the Government royalty or revenue on which exceeded half a million rupees.

SECTION II.—*Minor Forest Products*

Minor forest products are of considerable value in this zone, and in 1921-22 produced a revenue of Rs. 11,50,000 (out of a total revenue of Rs. 33,00,000 or over 1/3) from the forests of Bengal, Assam and Chittagong. Amongst the more important items may be mentioned:—

(1) *Bamboos.*—56 million bamboos were extracted, to a royalty value of Rs. 1,80,000. But this quantity, large as it sounds, represents only a small fraction of the available supply, and in the forests of the Chittagong hill tracts, in the adjoining forests of Assam and Arakan, as well as in the grassy savannah of the Brahmaputra valley, there is an enormous supply of raw material

available for the manufacture of paper pulp which is practically inexhaustible, and which could, if fully utilizable, meet the requirements of all Asia, Africa, and Australia.

(2) *Canes.*—Rs. 1,26,000 was the royalty received in 1921-22 from the sale of canes, which are sold in Assam chiefly on yearly leases of certain forest tracts. The actual quantity removed is not recorded, but since the royalty rate is based on a figure of 8,000 feet per rupee, it may be roughly estimated that something like a thousand million feet of canes were extracted during the year.

(3) *Wild Elephants.*—The catching of wild elephants (*khedda* operations) forms an important branch of forest activities in parts of Bengal and Assam, especially in the north Cachar hills, where in the six months, October 1921 to March 1922, nearly 300 elephants were caught, of which 263 were sold for Rs. 5,85,000 or Rs. 2,225 per elephant. In addition, about 40 elephants were caught in other parts of Assam and Bengal. These *khedda* operations are usually carried out on the share system between Government, the stockade men, and the owners of the *koonkies* (tame elephants used for driving and capturing the wild herds), and the Government share for the whole tract amounted to Rs. 2,25,000.

4. THE FORESTS OF BIHAR AND ORISSA, CENTRAL PROVINCES AND BERAR

The forests of this zone are bounded by the Gangetic Plain on the north, the Bombay Deccan on the west, the Madras Presidency on the south, and the sea on the east, and consist chiefly of the type of forest which Troup has described as 'Central Indian.'

SECTION I.—*Timber and Fuel*

(*a*) *Bihar and Orissa.*—The bulk of the forests of Bihar and Orissa, including all the State forests, lie in the hilly regions of Chota Nagpur and Orissa. In these regions the total area of forest amounts to something like 35,000 square miles, of which only 3,508 square miles or

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about 10 per cent belong to the State, the remainder belonging to private owners or lying outside British India altogether.

The forests are practically all of the deciduous type, with *sal* the dominant species except on the driest soils. Other common species of economic importance comprise *Pterocarpus Marsupium*, *Terminalia tomentosa*, *Anogeissus latifolia*, *Bursera serrata*, *Bassia latifolia*, *Adina cordifolia*, *Acacia Catechu*, *Dendrocalamus strictus*, *Bambusa arundinacea*, and others too numerous to specify. Teak is indigenous in one or two small areas in Orissa and it has been artificially introduced on a large scale in another Orissa division, Puri.

The forests vary greatly in density and quality. The *sal* forests of Singhbhum district in Chota Nagpur are amongst the finest and most fully stocked in India and in the past they have contributed more than half of the total forest revenue of the province. Good quality *sal* does occur elsewhere in other districts but as a general rule it is inferior in density and quality to that found in Singhbhum. In the drier localities *sal* disappears and the forests consist of miscellaneous species of open stocking and poor quality, the bamboo, *Dendrocalamus strictus*, usually proving the most valuable product.

Present volume of output and uses.—The present annual out-turn of timber and fuel averages about 2,500,000 and 17,500,000 cubic feet respectively. Of the timber about 900,000 cubic feet is converted into sleepers of all sizes, and about 100,000 cubic feet is sawn into scantlings of various dimensions for house-building, furniture, etc. The balance of 1,500,000 cubic feet comprises poles which are mainly utilized by the local villagers for house construction purposes, but which are also utilized on a small commercial scale for pit props, etc. Except for a considerable quantity of firewood converted into charcoal for export for commercial uses the whole of the annual output of firewood is utilized by the local villagers and townspeople.

About 10,000,000 bamboos are annually removed from the state forests for purely local uses such as house-building, fencing, basket-making, etc. No bamboos are

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commercially exploited at present, but the possibilities for bamboo pulp manufacture are very favourable, especially in Cuttack.

(*b*) *Central Provinces and Berar.*—The great bulk of the forests in this region consist either of (1) mixed deciduous forests of a type which is virtually a dry form of monsoon forest, (2) *sal* forests, or (3) thorn forests. The distribution of these types is determined partly by climatic conditions, but also to a considerable extent by soil conditions.

(1) *The mixed deciduous forests* vary in composition, but the prevailing trees are *Tectona grandis*, *Terminalia tomentosa*, *T. belerica*, *T. Chebula*, *Anogeissus latifolia*, *Lagerstroemia parviflora*, *Pterocarpus Marsupium*, *Dalbergia latifolia*, *Ougeinia dalbergioides*, *Cassia Fistula*, *Acacia Catechu*, *Butea frondosa*, *Adina cordifolia*, *Stephegyne diversifolia*, *Bridelia retusa*, *Phyllanthus Emblica*, *Cleistanthus collinus*, *Diospyros Melanoxylon*, *Bassia latifolia*, *Soymida febrifuga*, *Schrebera swietenioides*, *Chloroxylon Swietenia*, *Odina Wodier*, *Buchanania latifolia*, *Schleichera trijuga*, and various other trees; the prevailing bamboo is *Dendrocalamus strictus*. On ridges and in other dry situations the forest is often of a special kind in which *Boswellia serrata*, *Sterculia urens*, and *Cochlospermum Gossypium* are the chief species. In the moister types of forest to the south-east of this region *Xylia xylocarpa* becomes common. As a general rule the mixed deciduous forests of this region do not contain trees of large dimensions, and compare unfavourably in this respect with the mixed deciduous forests of the West Coast or of Burma. In the more favourable localities, as in moist ravines and on deep fertile soil, forests of very fair quality are produced, but over a considerable portion of the region the forest is of a dry type often merging into thorn forest. Teak trees of small size are very plentiful in places and the quality for decorative uses is superior [illegible] larger timber of other localities. There are various special types of mixed deciduous forest in this region, one of the most notable being the *anjan* (*Hardwickia binata*) type found either on trap or on sandy and gravelly soil overlying granite, schist, quartzite, conglomerate, or sandstone.

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In parts of Central India *Anogeissus pendula* grows gregariously, forming a special type of forest. Some of the drier and more open types of mixed deciduous forest, in which rather stunted trees are scattered over grassy expanses, may be classed as dry savannah forests.

(2) *The sal forests* extend through the eastern part of the Central Provinces, the greater part of Chota Nagpur and Orissa, and the north-eastern portion of the Madras Presidency. Their distribution is determined largely by the hygroscopicity of the soil and subsoil, for which reason they avoid trap areas, which are too dry for their existence. Associated with the *sal* forests are occasional tracts of savannah land.

(3) *Thorn forests* occur in all the drier parts of this region, chiefly on the more level ground on the extensive plateaux of Central India. They are of an open character, vary in composition, and consist to a large extent, though by no means exclusively, of thorny species, many of which belong to the *Leguminosae ;* among characteristic species of the thorn forests of this region may be mentioned *Acacia arabica*, *A. leucophloea*, *A. Catechu*, *Dichrostachys cinerea*, *Balanites Roxburghii*, *Butea frondosa*, *Phyllanthus Emblica*, *Zizyphus Xylopyrus*, *Z. nummularia* and *Z. jujuba*. *Prosopis spicigera* occurs only in the driest parts of this region. Thorn forest is specially characteristic of trap areas and black cotton soil, though by no means confined to such ground.

The total area of forest land in the Central Provinces and Berar is nearly 20,000 square miles, but most of this is of the dry scrub type incapable of growing large and valuable timber, and the good quality *sal* and teak forests are of limited extent. Large areas of these forests have also very poor export facilities. The output of timber and fuel in 1921-22 were seven million and twenty million cubic feet respectively, valued at Rs. 15,00,000 and Rs. 5,00,000. The low royalty value of fuel (i.e. forty cubic feet per rupee) may be noted. With improved railway communication, both the total quantity exported and average royalty value of timber and fuel would materially increase.

The Central Provinces forests are of enormous importance in supplying grass and grazing; normally about three million cattle graze yearly, and grazing fees realize about one million rupees, or an average of sixpence per animal per annum! In other ways also the well-being of the agricultural classes is intimately dependent on the Central Provinces forests, as the following figures show:—

Produce given away in concession or free grants	Quantity	Value
		Rs.
Timber	380,000 c. ft.	1,43,000
Fuel	5,000,000 c. ft.	
Bamboos and minor products	...	56,000
Grass	35,000 tons	52,000
Grazing	...	9,92,000
Total free grants ...	...	12,43,000

SECTION II.—*Minor Forest Produce*

The forests and waste lands of this zone are very rich in minor forest products. Of these by far the most important is lac; about eighty per cent of the world's supply is obtained in this zone, to an average annual quantity exceeding 15,000 tons and to an average annual value of four to five million pounds. Intensive lac cultivation has been seriously taken up in several areas, notably in the Damoh division of the Central Provinces, with excellent financial results. The question of lac has been described in detail elsewhere in this book. Other important minor products obtained or obtainable from this

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zone are myrabolans, cutch and katha, mohwa flowers and fruits, rosha oil, kuchela (nux vomica) seeds, *Boswellia* gum-oleo-resin, tan materials, *sabai* grass and bamboos for paper pulp, etc. As these will be described in greater detail in a subsequent chapter, further reference to them here is unnecessary.

5. FORESTS OF BOMBAY, GUJARAT AND THE WESTERN PENINSULA

There are two very distinct zones of forest which supply the markets of Bombay and the Western Peninsula, which are respectively :—

(A) The forests of the Bombay Deccan.
(B) The forests of the West Coast and Western Ghauts.

These will be considered and described separately.

A. THE BOMBAY DECCAN AND SATPURAS

(*a*) *Brief description of main forest types and species with area.*—The typical forests of the Bombay Deccan are situated in very broken irregular areas, over the western part of the area known as the Deccan.

This Deccan (the name of which is derived from the Sanskrit word *dekshin*, meaning south or southern country) is an undulating plateau, which really forms the core of the triangle of the Indian Peninsula. Its elevation varies, but may be taken as approximately 2,000 ft. more or less. It has a geological formation of a basalt trap, and this produces characteristic flat-topped hills, some of which are capped with red laterite.

The features of the country are a very dry climate, with rainfall of 10 inches to 35 inches ; and much of the soil is rocky and stony, though large areas contain the celebrated black cotton soil.

The whole area stretches parallel to the Bombay coast for a distance north to south of about 500 miles and is about 200 miles broad.

The northern portion is known as Khandesh, and the bulk of the forests in this area are found on the Satpura

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Hills, which run in a south-easterly direction from the Nerbudda river to the Central Provinces boundary. This is not strictly the Deccan proper, but as conditions there are very similar, it may be included in it. Travelling from north to south the forests lie in the districts of West Khandesh, East Khandesh, Surat, Nasik, Poona, Ahmednagar, Sholapur, Satara, and in the northern portions of Dharwar and Belgaum. The bulk of the forests being situated on dry rocky hills, the general type is a dry mixed forest of teak and other deciduous species, varying from scrub to pole or semi-high forest type, except in Akrani where good teak forest occurs. In such forests, no large timber is produced, and most of the material is sold locally. The chief species are teak, *Terminalia tomentosa*, *Anogeissus latifolia*, *Odina Wodier*, *Boswellia serrata*, *Buchanania latifolia*, *Acacia Catechu*, *Prosopis spicigera*, *Diospyros Melanoxylon*, *Dalbergia latifolia*, *Hardwickia binata*, *Sterculia urens*, *Schleichera trijuga*, *Bassia latifolia*.

The area covered by such forests is approximately 6,600 square miles.

Besides the above there are two other classes of forest which must receive notice.

South of the Tapti river and immediately south of the Tapti Valley Railway is an extremely rugged broken area of country known as the Dangs, in the Surat political agency, and joining on to this on the south-west boundary is another similar area of country, forming the Peint taluka of the Nasik district.

These two areas together comprise over 1,000 square miles of forest and contain by far the most valuable timber forests of the whole area. They produce splendid timber of teak, blackwood, *Terminalia tomentosa*, *Adina cordifolia*, *Ougeinia dalbergioides*, *Acacia Catechu*, and a few other species. The much improved quality of the timber is chiefly due to the higher rainfall in this area.

Finally, scattered about the whole area, on flat black soil, chiefly on the banks of rivers and nullahs, there are small detached pieces of riverain forests containing chiefly *Acacia arabica* (*babul*) trees.

(*b*) *Present volume and value of output and uses.*—The whole area above described may be said to produce an annual yield of approximately two million cubic feet of timber, of which about two-thirds is teak. Out of this, the only timber which can be classed as really good is that produced in the Dangs and in the Peint district, which may amount to 150,000 cubic feet annually, of which about 120,000 cubic feet are of teak, and the rest blackwood and other jungle timbers.

The total value of this timber amounts yearly to about Rs. 15 lakhs.

In addition, the area produces about ten million cubic feet of fuel, fetching Rs. 6 to 7 lakhs.

Finally, there are sold every year about Rs. 50,000 worth of bamboos, Rs. 5 lakhs' worth of grass and grazing, and Rs. 75,000 of other minor forest products.

Most of the timber and fuel is disposed of locally, in the area, but the timber from the Dangs and from Peint, being of a much higher quality, naturally finds a much wider market. It is sent by rail eastwards and sold in the markets of the Central Provinces. Much of it also goes north by rail to the large cotton areas of Gujarat such as Surat, Broach, Ahmedabad, etc., and some is disposed of in Bombay city.

(*c*) *Further possibilities of development and increased output.*—There is a very strong probability of great future developments and increased output in the valuable timber forests of the Dangs and of Peint. The forest officers and forest engineers in Bombay are at present engaged in drawing up large schemes for the opening out and exploitation of these forests, which will involve the construction of metalled roads, and of a light railway through the forests of the southern Dangs.

The only other possibilities of development are (1) the oleo-resin industry in the Satpura Hills of Khandesh, where there are millions of *Boswellia serrata* trees (it is understood that one private firm has already obtained a concession for the distillation of various products from the resin of these trees), and (2) intensive utilization of myrabolans.

B. THE WEST COAST

SECTION I.—*Timber and Fuel*

(*a*) *Brief description of the main forest types and species with areas.*—The forests of the West Coast, within the limits of the Bombay Presidency, may be said to fall into three large groups.

The first group is situated in the Thana district immediately to the north of Bombay city; it stretches from the coast inland, and forms roughly the apex of the triangle made by the junction of the Bombay, Baroda and Central India, and Great Indian Peninsula, Railways, which meet just outside Bombay city.

These forests from their proximity to the great city and from the fact that they are most accessible to railways, roads and creeks, are of great value.

They form three forest divisions and their total area is approximately 1,500 square miles. The forests consist of mixed teak forest, of fair and sometimes pretty good quality, due to the considerable rainfall and other favourable conditions, but nowhere do they attain very large timber size. The percentage of teak is often high. The other common species are *Terminalia tomentosa*, *Dalbergia latifolia*, *Anogeissus latifolia*, *Acacia Catechu*, *Ougeinia dalbergioides*, *Stephegyne parviflora*, *Adina cordifolia*, *Odina Wodier*, and others.

The second group is situated in the Kolaba district, on the coast immediately to the south of Bombay city, forty to fifty miles away. The total area is about 500 square miles and the composition of the forests is somewhat similar to that of the Thana group, but not of such a good quality.

The third group comprises the well-known valuable timber high forests of the southern Bombay coast, which stretch from the Kanara coast inland, within the districts of Kanara and part of Belgaum and Dharwar. There are no less than five forest divisions in Kanara, one in Belgaum and one in Dharwar. The total area of this group is approximately 4,000 square miles.

Naturally, over such a large area, there are many variations in the types and in the growths of the forests concerned, but, speaking very generally, the forests may be divided into two sections. First the forests above the Ghauts and on the upper slopes of the Ghauts. These forests are of the moist deciduous type, and the trees in them are generally of splendid size and stature, and of great timber value. The principal species that these forests contain are teak, blackwood (*Dalbergia latifolia*), *Terminalia tomentosa*, *Terminalia paniculata*, the bentek (*Lagerstroemia lanceolata*), *Lagerstroemia parvifolia*, *Lagerstroemia Flos-Reginae*, *Pterocarpus Marsupium*, *Xylia xylocarpa*, *Adina cordifolia*, *Gmelina arborea*, and many others. Large masses of bamboos are found in these areas.

Secondly, on the lower slopes of the Ghauts and in the land lying below the Ghauts, where the climate is extremely hot and moist, there are extensive and dense evergreen forests, with straight-stemmed trees of great height, amongst which are found *Canariums*, *Calophyllums*, *Hopeas*, mangoes, *Vitex*, *Sterculia alata*, *Diospyros*, *Vateria indica*, *Dipterocarpus*, *Messua*, *Strychnos* and many others. A number of species of palms and canes also occur in this area.

Owing to the market for these valuable timber species not being developed, and the difficulty of their scientific working, these evergreen forests have as yet nothing like the same value as the moist deciduous types of forest, but they have great potential value.

The forests of southern Bombay have always been remarkable for the extensive network of metalled roads and bridges, throughout the area, for the extraction of timber and other produce.

The Madras and Southern Mahratta Railway runs through the northern part from Belgaum south-west to the port of Mormugao, and has a branch running southwards, built especially to tap some of the most valuable timber forests.

Finally transport by sea is available, both from Goa in Portuguese territory and from Karwar, Kumta and Batkhal in British territory.

(*b*) *Present volume and value, output and uses.*—The average annual output of timber from the forests of Thana and Kolaba, is approximately one million and a half cubic feet per annum, of which two-thirds to three-fourths is teak. Its value would be about Rs. 17 lakhs. The average annual output of fuel for this area is about four to five million cubic feet fetching approximately Rs. 20,000.

The bulk of this timber is sent northwards by sea and by rail to Gujarat and Kathiawar, where it commands a ready sale, especially in the rich cotton and agricultural districts of those areas.

Nearly all the fuel and charcoal from Thana and Kolaba is consumed in Bombay city, and there is a large trade in these commodities, which are transported to Bombay both by rail, and by boats, along the coast.

In addition this area produces annually Rs. 20,000 worth of bamboos, Rs. 17,000 worth of minor forest products, and Rs. 65,000 worth of grass and grazing.

The southern group of forests, comprising Kanara and part of Belgaum and Dharwar, has an average annual output of timber of approximately two and a half million cubic feet whose value amounts to from Rs. 20 to 21 lakhs, of which about two thirds is teak, and the rest valuable junglewoods.

It also produces ten to eleven million cubic feet of fuel, and charcoal, which sells for Rs. 6 to 7 lakhs.

It also produces yearly about Rs. 70,000 worth of bamboos, Rs. 3 to 4 lakhs' worth of grass and grazing, and Rs. 2 to 2½ lakhs' worth of other minor forest produce.

Kanara itself yields on an average yearly about 10,000 large teak trees, over six feet in girth, with a total volume of about 8,000 to 9,000 tons of timber, and approximately 12,000 large miscellaneous timber trees, especially of blackwood, with a total volume of 9,000 to 10,000 tons of timber. The timber from this area, being of very fine quality, commands a world market, but much is disposed of in Bombay city. Some of the fuel goes by boat to Bombay and the rest finds local markets.

(*c*) *Further possibilities of development and increased output.*—There is not much chance of development in the northern group of forests, where the utilization, in many places, is already very complete.

There are great possibilities of development in the near future in the forests of Kanara, by means of increased and improved communications.

Roads are being made yearly, and the question of further opening out the forests, by means of light railways, is being vigorously tackled.

The Bombay Government have already sanctioned the construction of one logging railway nine miles long, costing Rs. 2,90,000, for the extraction of timber, etc., and another light logging railway is under consideration.

SECTION II.—*Minor Forest Produce*

Myrabolans.—The *hirda* tree (*Terminalia Chebula*), which produces the *chebulic myrabolans*, occurs over large areas of the Bombay forests in varying quantities.

It is chiefly found in the Ghaut evergreen or semi-evergreen forests of the following districts: Thana, Nasik, Ahmednagar, Poona, Satara, Belgaum, and Surat. It is regularly exploited annually by the Forest Department, and, as a rule, the right to collect over a certain area is sold to the highest bidder.

Tans.—The best tanning materials in Western India are the barks of the *babul* tree (*Acacia arabica*), and *Cassia auriculata.* The former tree grows in small patches of riverain or nullah forest, in the drier parts of the area, especially in Khandesh, Ahmednagar, Satara, Poona, and parts of Dharwar, Sholapur and Belgaum.

Regular annual fellings, under regular working plans, are made in such forests and the bark is stripped, stacked, and disposed of locally, chiefly by contractors.

Boswellia.—Mention has already been made of the enormous number of *Boswellia serrata* trees which grow right through the drier portions of the Satpura range of hills in Khandesh and the tree also occurs freely in some of the drier parts of the Deccan.

Cutch.—Acacia Catechu, the tree which produces cutch, grows freely over large areas of mixed forests in Western India, except in the very damp and evergreen areas. In some parts it attains a very large size.

There was formerly a most extensive cutch industry in Western India, but as the value of the wood, both for timber, fuel and charcoal, has risen so much the industry, in Government forests, has died down to almost nothing at all.

A large trade is carried on from the coastal forests of Kanara in a large variety of minor products, as for example, soap nut, marking nut, *divi-divi*, nux vomica, etc.

6. THE FORESTS OF MADRAS AND SOUTHERN INDIA

SECTION I.—*Timber and Fuel*

(*a*) *Brief description of main forest types and species with area.*—Starting from the north of the presidency we find ourselves within the *sal*-bearing area of the north-east of the peninsula. Considerable areas of *sal* (*Shorea robusta*) forest are found in both Ganjam and Vizagapatam districts. Interspersed with the *sal* forest in both the districts is a mixed deciduous forest of many species extending along the foot and slopes of the Eastern Ghauts as far as the Godavari river.

Up to an elevation of about 4,000 ft. along the Eastern Ghauts, with a rainfall of about 60 inches, the conditions are favourable for excellent growth of forest of this type. *Tectona grandis* (teak) occurs only towards the south of this area in the neighbourhood of the Godavari valley and *Xylia xylocarpa* (ironwood) is not found in the Ganjam district but occurs in the Godavari district. The bamboos (*Dendrocalamus strictus* and *Bambusa arundinacea*) are found throughout the area.

Following the Eastern Ghauts southwards we reach the *Hardwickia* forests of the Guntur uplands bordering the Kistna river. Rainfall here probably does not exceed 40 inches and the rainless season extends to eight months of the year. The forest is often poor and stunted, with greater prevalence of *Acacias* and other species.

With the bending of the Eastern Ghauts towards the south-west we enter upon the dry forest zone of the districts of Kurnool, Cuddapah, Bellary and Anantapur. At the higher altitudes of the Nallamalai hills with a rainfall up to 60 inches the forest growth resembles that of the more northern districts mentioned above. *Sal* is absent, but valuable timber trees such as *Tectona grandis*, *Pterocarpus Marsupium*, *Anogeissus latifolia*, *Adina cordifolia* and the *Terminalias* grow well.

As we progress southwards and westwards, the rainfall diminishes and the forest growth deteriorates. *Hardwickia binata*, *Pterocarpus santalinus* (red sanders), *Terminalia Chebula*, *Anogeissus latifolia* and *Swietenia Chloroxylon* (satinwood) are the principal timber species to be found.

On the dry stony hills of East Kurnool and Bellary *Dolichandrone falcata*, *Wrightia tinctoria*, *Acacias* and *Albizzias* form a large percentage of the crop. The varieties of *sal* (*Shorea Tumbuggaia* and *Shorea laccifera*) also appear with a very limited local distribution in the districts of Cuddapah and Chingleput.

Again, following the Eastern Ghauts in their westerly turn through the districts of North Arcot, Chittoor, Salem and Coimbatore, we pass through the sandalwood (*Santalum album*) area. This valuable tree appears to thrive best at altitudes from 2,000 to 4,000 ft. with a rainfall of 40 to 60 inches. Together with the sandalwood at these elevations are found:—

Acacias.
Albizzias.
Anogeissus latifolia.
Dalbergias.
Pterocarpus Marsupium.
Strychnos Nux-vomica.
Strychnos potatorum.
Teak.
Terminalias.

and most of the species of the mixed deciduous forest described above. At a lower elevation and in the very dry regions of parts of Tinnevelly, Madura and Coimbatore with a rainfall approximating to 20 inches, the forest degenerates into a dry scrub jungle of *Acacias* and *Albizzias*.

Before leaving the eastern side of the presidency reference must be made to two other types of forest.

Along the East Coast within the reach of the damp sea-breezes a type of stunted evergreen forest is found. Chief among the trees of these forests are :—

Chloroxylon Swietenia.
Diospyros Ebenum.
Diospyros Melanoxylon.
Eugenia.
Memecylon.
Mimusops hexandra.
Soymida febrifuga.

together with a large number of evergreen thorny shrubs such as *Randia*, *Canthium*, *Zizyphus*, etc.

The second of the types referred to is that of the forest on the alluvial land at the mouths of the big rivers. The presence of salt water is the modifying agent as regards the specific forms which characterize the composition of this forest. The chief species found are :—

Aegiceras majus.
Avicennia officinalis.
Ceriops Candolleana.
Excaecaria Agallocha.
Kandelia Rheedii.
Sonneratia acida.

We have lastly to consider the forests at the foot and on the slopes and plateaux of the great Western Ghauts comprising the Palnis, the Anamalais, the Nilgiris and the Wynaad, Coorg and Kanara hills. The rainfall of this region varies from 120 inches on the littoral to upwards of 250 inches on the upper slopes,on which the monsoon breaks and from 60 to 150 inches on the plateaux which lie inland of the main range. The type of forest is dependent on the altitude and rainfall. With a rainfall of 150 inches and over or at an altitude of about 4,000 ft. the forest is mainly evergreen. In these forests the trees often grow to enormous size, with straight, clean boles of 80 feet to the first branch and with a total height of 200 feet and more. Some of the more valuable species found are :—

Aglaia Roxburghiana.
Artocarpus hirsuta.
Bischofia javanica.
Calophyllum tomentosum.
Canarium strictum.
Cullenia spp.
Dichopsis elliptica.
Hardwickia pinnata.
Hopea parviflora.
Litsaea spp.
Machilus macrantha.
Mesua ferrea.
Myristica spp.
Nothopegia Colebrookiana.

Diospyros spp.
Dipterocarpus indicus.
Eugenia spp.
Gluta travancorica.
Tetrameles nudiflora.
Vateria indica.
Xylia xylocarpa.

A characteristic of the forests is the immense stock of timber which they carry to the acre and often profuse natural regeneration of species found on the ground.

On the lower slopes of the ghauts and on the litoral the evergreen forests give place to deciduous forest which on the deep soil and with the heavy rainfall common to the West Coast reaches in these conditions its maximum development. Similar forest is also found on the lower plateaux of the main range where the rainfall varies from as much as 200 inches on the west to 60 inches on the east.

Lastly there is the stunted evergreen *shola* forest of the Western Ghauts at elevations of from 6,000 to 8,000 ft. The characteristic of this forest, in which the growth seldom exceeds fifty feet in height, is the occurrence of bracken, *Rubus*, *Rhododendron* and other species of a temperate climate.

The grand total of reserved forests and waste lands under the control of the Forest Department in the Madras Presidency amounts to 18,800 square miles.

(*b*) *Present volume and value of output and uses.*

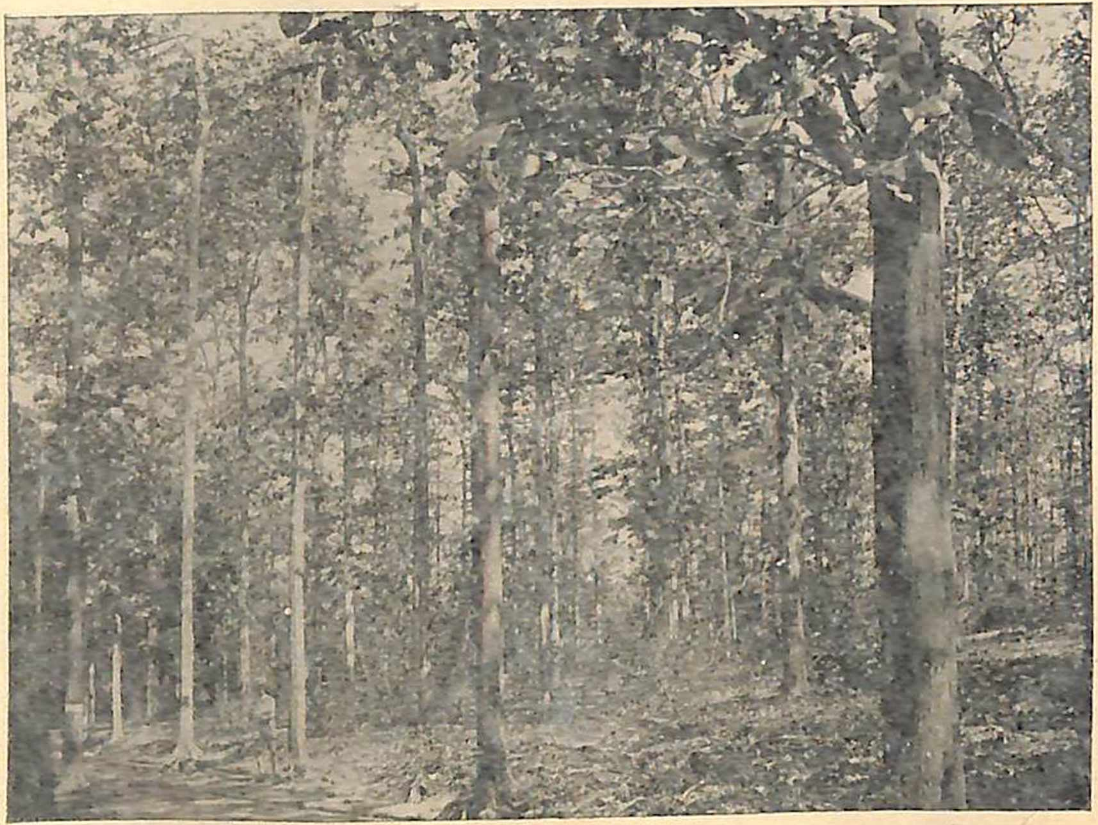
Timber.—The output of timber in the State forests of Southern India during the year ending 31st March 1922 was 108,400 tons, of which 20,825 tons were extracted by departmental agency and 81,675 tons by purchasers. The value of timber removed from the forests by Government agency during the year was Rs. 7·75 lakhs, while that extracted by purchasers was Rs. 3·22 lakhs. The sale of teak timber from Nilambur plantations has always figured largely in the returns and Rs. 2·64 lakhs was realized by the sale of departmentally extracted timber in Nilambur alone.

Fuel.—The total out-turn of fuel was 324,666 tons, of which 49,316 tons were removed departmentally and 273,950 tons by purchasers. The total value of fuel removed by these two agencies was Rs. 7·62 lakhs. The bulk of this revenue, viz., Rs. 7·04 lakhs, was mainly derived from sale of standing forests to fuel contractors who remove the fuel for sale in the larger towns and villages. The expansion of yield and revenue is due to the great efforts made by the department to meet the ever-increasing demand for fuel and charcoal in the towns, not only for domestic purposes but also for industrial concerns.

Sandalwood.—Sandalwood, being a valuable commodity, is collected departmentally mainly in North Arcot, Salem, and Coimbatore districts. About 520 tons were sold in the auction sales held in December last at Satyamangalam, Tirupattur and Vellore, which fetched a revenue of Rs. 6·05 lakhs. The average price secured per ton was Rs. 1,160.

(*c*) *The future possibilities of development.*—There are great possibilities of development in the forests of South Kanara, Nilambur Valley, Wynaad, Mount Stuart and the evergreen forests of Malabar and Tinnevelly. The standing forest crop in these forests is estimated at 648 millions of cubic feet. The possible net revenue when these forests are fully developed is estimated at Rs. 36,22,500. In addition to these forests, there are *sal* forests in the Khond Agency, the agency forests of Golconda, Rampa and Bhadrachalam (the value of which is little known although they undoubtedly contain teak, rosewood, *Terminalias* and other valuable timber and a very large quantity of bamboos), and the central portion of the Nallamalais, of which little or no information is available but which deserve investigation by experts as possible sources of revenue to the State.

A saw-mill was recently established at Russelkonda in Ganjam district to bring into the market the timber in the *sal* forests of Ghumsur. The scheme for the development of the Chenat Nair forests in Malabar has made great progress, extraction being assisted by caterpillar tractors and improved timber slides. Large quantities of timber from these forests are being despatched to the Kolar Gold Fields and arrangements are being made to test little known varieties of timber for tea and rubber chests and kerosine oil cases. The



Nilambur teak plantation, Madras Presidency.

whole question of the future development of the timber resources in the State forests of Southern India has been under close examination by Government and they have recently sanctioned the proposals made by the Chief Conservator for the formation of a special Engineering and Utilization branch of the department in order to facilitate the exploitation of the enormous property at their disposal.

SECTION II.—*Minor Forest Produce*

Bamboos.—This is an important source of revenue in Southern India. The total value of bamboos extracted by all agencies was Rs. 3·21 lakhs. The bulk of this revenue is derived from the sale of bamboo coupes to purchasers. In the Rampa agency large quantities of bamboos are extracted on the permit system.

Grass and Grazing.—The revenue realized from grazing and fodder grass during 1921–22 amounted to Rs. 7·90 lakhs. The total number of animals licensed to graze was about 1¾ million. Goats are entirely excluded from reserves and the number of sheep admitted is being gradually reduced. The fees for grazing have been steadily raised and are now in certain forests Re. 1 per annum per cow unit compared with a maximum rate of three annas in 1890. The average fees are still very low and work out to about eight annas per head for a year's grazing. The average grazing incidence is 5·75 acres per animal but in the majority of grazing grounds it is heavier than they could reasonably be expected to bear, being as high as one acre per animal in some cases.

Other minor forest produce.—The revenue from other minor forest produce amounting to Rs. 6·71 lakhs is derived from a great variety of produce such as tamarind, soap nut, wax, gum, skins, horns, elephant tusks, honey, gall nuts, nux vomica, turmeric, cardamoms, paper, catechu, plumbago, limestone, etc. Minor produce is also collected departmentally by jungle tribes such as the Chenchu of Kurnool who are encouraged, in an effort to keep them out of the clutches of sowcars and toddy drawers, to collect forest produce for sale to the Forest Department.

Lac.—Attempts were made in 1916-17 to introduce lac into Kurnool district, the trees inoculated being *Butea frondosa* and *Zizyphus jujuba*, but owing to exceptional floods in September 1916 they proved a failure. The lac was procured from Maihar Rewa State, Central Provinces. Later, at the instance of the Agricultural Department, experimental cultivation of lac was carried on for a period of two years in the Bolampatti forests, Coimbatore district. *Zizyphus* trees were selected for the purpose. The experiment, however, failed. In order to make lac cultivation a success it is considered necessary to introduce families of lac cultivators from the Central Provinces who can be trusted to carry out the work as it should be done.

Myrabolans.—Myrabolans are available in large quantities but they are not much sought after as a tanning material in Madras, being generally left to rot on the ground. There have been large exports, however, of this material to Europe from the ports of Cocanada and Bimlipatam.

Tans.—The various tanstuffs found in this Presidency are :—

(i) *Cassia auriculata* (*avaram* or *tangedu*).
(ii) *Cassia Fistula* (*konnai* or *rela* bark).
(iii) *Anogeissus latifolia.*
(iv) *Terminalia Chebula* (myrabolan).
(v) *Cæsalpinia* (*divi-divi*).

Of these (i) is the principal tanning material.

Enquiries recently made show that large quantities of *Cassia auriculata* are available, mostly outside the reserved forests, far in excess of the demand which is practically nil at present owing to the slump in the market.

Large supplies of *Anogeissus latifolia* and *Acacia dealbata* could be arranged if they prove to be really useful tanstuffs.

The whole business of marketing *Cassia auriculata* and *Cassia Fistula* from the forests was handed over in 1917 to the Munitions Board in return for a fixed payment based on the average revenue derived by the Forest Department from tanstuffs during the five years preceding the War. This arrangement involved during the year 1917-18 a sacrifice of about Rs. 3 lakhs which was part of the Madras contribution to the War. The Munitions Board expressed its appreciation of this concession.

Large quantities of *Anogeissus latifolia* were also supplied to the Munitions Board for tanning purposes.

In 1918-19 the collection of tanning bark was continued under the agency of the Munitions Board. The total quantity collected was 56,917 candies. The year's rentals were Rs. 4,77,643-3-8 and the Department obtained credit for Rs. 2,62,488, thus sacrificing a revenue of over 2 lakhs.

In 1919-20, unprecedentedly high prices were obtained for tanning bark leases owing to the withdrawal of Government control over prices. Later the market price fell considerably owing to the withdrawal of the prohibition against the exportation of raw hides and to the sale of Australian and African wattle bark in the Indian markets. The tanning contractors, having speculated and lost heavily, applied for concessions, and with a view not to handicap the industry the Government granted them a rebate of 15 per cent. on the sale amounts. The total lease amount for the year received by the Department amounted to Rs. 7,60,584 compared with Rs. 5,72,328 in the previous year.

Cutch.—This is obtained in very limited quantities in South Kanara.

Pulp.—Jungle grasses and bamboos are considered from the forest point of view to be the main sources of pulp available.

The Carnatic Paper Factory, Madras, was supplied at the cost of Government with various jungle grasses from the forests of Cuddapah and Bellary. The pulp manufactured therefrom was sent to Dehra Dun and was tested at the Titaghur Paper Mills. The results were unsatisfactory and the company abandoned grass pulp in favour of bamboo pulp.

Before the War, Messrs. Nelson and Sons proposed to start a bamboo pulp and paper industry in Malabar, but owing to the dying back of the bamboos in that locality the idea had to be abandoned.

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The Carnatic Paper Factory also proposed to utilize the bamboo forests in the Godavari division for the manufacture of paper pulp and to establish a mill at Rajahmundry. The bamboos began to flower in that locality also, and the project was abandoned.

7. THE FORESTS OF BURMA

Introduction.—The total area of forests in Burma is as follows :—

Reserved Forests	...	30,159	square miles.	
Unclassed Forests	...	114,622	,,	,,
Total	...	144,781	,,	,,

The area of unclassed forests given is however largely guesswork and while there are still large areas which should be reserved the greater portion of the area shown as unclassed is either inaccessible or of little value. In the following note as a general rule the area covered by reserved forests only will be considered.

With such an enormous area it will be readily realized that it is quite impossible to deal with the forests of Burma as a whole. Further subdivision is essential.

A glance at the map of Burma will show that Burma can be roughly divided into three main longitudinal zones.

The Western or Arakan Zone is bounded on the east by the Chindwin and the Lower Irrawaddy.

The Central Zone lies between the Chindwin and the Lower Irrawaddy on the west and the Upper Irrawaddy and the Sittang on the east. The Dry Zone south of Mandalay separates the Irrawaddy at Mandalay from the Sittang at Pyinmana but there is no high land between the two river systems here. For convenience the forests to the east of the Irrawaddy north of Mandalay may be included in the Central Zone.

The Eastern Zone lies to the east of the Dry Zone south of Mandalay and of the Sittang valley and stretches down south to Moulmein and to Tavoy and Mergui.

From the point of view of the economic importance of the forests it is necessary further to subdivide these three zones into ranges as follows :—

I. *Western Zone*—
    1. Arakan Yomas.
    2. The Chindwin.

II. *Central Zone*—
    3. The Irrawaddy Delta.
    4. The Pegu Yomas.
    5. The Dry Zone.
    6. The Upper Irrawaddy including the drainages of the Mu and Shweli rivers.

III. *Eastern Zone*—
    7. The East Sittang basin.
    8. The Shan Hills including the foothills north of the Sittang basin.
    9. Moulmein including the Thaungyin, Ataran and Lower Salween.
    10. Tenasserim including Tavoy and Mergui.

The reserved forests have recently been classed according to accessibility and to area required for local supply or available for commercial supply. The table on p. 66 shows the area under each class for each of the ranges given above. It must be remembered that information for the greater portion even of the reserved forests is meagre and the figures given are necessarily extremely rough. They are however useful in giving some idea of the different classes of forest.

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Zone	Range	AREA OF RESERVED FORESTS IN SQUARE MILES				Total Reserved forest	A rough estimate of unclassed forest
		Required for local supply	Accessible or likely to be accessible in the near future--		Inaccessible or not capable of producing timber of commercial quality. Includes climatic reserves		
			For all timbers	Only for timbers which will float			
Western ...	1. Arakan Yomas	1,218	1,148	1,499	1,796	5,661	25,712
	2. Chindwin	...	901	2,646	377	3,924	14,652
Central ...	3. Delta	3	304	...	712	1,019	492
	4. Pegu Yomas	1,140	1.683	2.783	1,252	6,858	6.360
	5. Dry Zone	242	...	...	...	242	606
	6. Upper Irrawaddy ...	317	3,334	1,017	871	5,539	20,489
Eastern ...	7. East Sittang	204	185	64	90	543	3,623
	8. Shan Hills	761	625	786	861	3,033	19,537
	9. Moulmein	580	426	856	123	1,985	9,710
	10. Tenasserim	...	900	...	455	1,355	13,441
	Grand Total ...	4,465	9.506	9,651	6,537	30,159	114,622

BRIEF DESCRIPTION OF THE MAIN FOREST TYPES
WESTERN ZONE

1. *Arakan Yomas.*—Starting in the south in the Bassein division the forests are mainly evergreen with the following characteristic species :—Dipterocarps of the moist type including *kanyin* (*Dipterocarpus* spp.), *kaunghmu* (*Parashorea stellata*) and *thingan* (*Hopea odorata*), *pyinkado* (*Xylia dolabriformis*) and *pyinma* (*Lagerstroemia Flos-Reginæ*). Further north bamboos become numerous, vast areas being covered with *kayinwa* (*Melocanna bambusoides*) with a very inferior stocking of trees, *kanyin*, *pyinkado* and *pyinma* being the species most frequently met with. Further north on the Arakan side are found somewhat larger areas of evergreen forest containing principally *kanyin* and *thinbaung* (*Buchanania lancifolia*), but this forest has been considerably reduced by *taungya* cultivation and it appears doubtful if there remains sufficient for commercial exploitation. On the east side of the Arakan Yoma much *kayinwa* is found in the central portion of the range but further north in the Minbu and Yaw divisions there is also a considerable area of dry deciduous forest with bamboos containing teak in some quantity. *Pyinkado* and *padauk* (*Pterocarpus macrocarpus*) are also found, but the forests are far too inaccessible for the extraction of anything except teak.

The Arakan Yoma has been the least explored of any of the forests of Burma. Most of the forests are either inaccessible or of little value. There are no natural teak forests on the Arakan side of the Yomas, though teak has been planted with some success, while the teak forest on the east side of the Yomas is remote and inaccessible for any timber that cannot be floated. The forests of the Bassein division in the extreme south of the range are the most promising for commercial working, but working plans have had to await survey, which is only now being carried out, so that no estimate of the stock can be given.

Working Plans.—Rough working plans dealing with the selection felling of teak only have been drawn up for 914 square miles in this range, all in the Yaw division.

Of this area 559 square miles are classed as productive teak.

2. *The Chindwin.*—Generally speaking the Chindwin forests are of the deciduous type with bamboos characterized by teak and *pyinkado* as the most important commercial species. In the Lower Chindwin there is much drier forest with bamboos, and generally along the banks of the Chindwin in its middle reaches there are forests of *indaing* available for the supply of *in* (*Dipterocarpus tuberculatus*). In the higher reaches of the Chindwin and especially in Mansi division there is considerable evergreen forest characterized by *kanyin* with occasional trees of *sagawa* (*Michelia*) and other allied evergreen species, but these are not accessible. With the exception of the *indaing* forests near the river the forests are too remote to be accessible for any but floatable timber, which practically limits the extraction to teak only. There are very large supplies of *pyinkado* in the forests but it is hard to see how these can be made available owing to the scattered and sparse stocking and the difficult nature of the country.

Working Plans.—These cover 1,910 square miles, of which 1,172 square miles are classed as productive of teak. The Working Plans only prescribe the selection marking of teak and do not deal with other species.

CENTRAL ZONE

3. *Delta Range.*—This comprises all the Sunderbans forests of the Irrawaddy delta. The most important and most characteristic species is *pinle kanazo* (*Heritiera minor*). The available supply has however been seriously depleted by illicit extraction for fuel, the demand for which is very great, as transport by water to Rangoon and the larger towns in the delta is cheap and easy. A valuation of stock is now being carried out and an aerial survey has also been completed.

4. *The Pegu Yomas.*—These forests, covering both slopes of the main ridge (Yoma) between the Irrawaddy on the west and the Sittang on the east, comprise the most valuable block of teak forest in Burma. Starting in the

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south in Insein and South Pegu divisions, where evergreen forest, characterized by Dipterocarps of the moist type such as *kanyin* largely predominates, the forest changes to the deciduous type with bamboos further north and continues mainly of this type until the main ridge finally loses itself in the plains of the Dry Zone. Besides teak *pyinkado* is found in quantity almost throughout, while other conspicuous species found more locally include *taukkyan* (*Terminalia tomentosa*), *ingyin* (*Pentacme suavis*), *thitya* (*Shorea obtusa*), *in* (*Dipterocarpus tuberculatus*), *pyinma* (*Lagerstroemia Flos-Reginæ*), *leza* (*L. tomentosa*), *cutch* (*Acacia Catechu*) and many others.

This range contains the most important forests in Burma and much of the Working Plan and silvicultural work of the past has been carried out in them.

Of the total area 5,443 square miles are covered by Working Plans, of which 3,335 square miles are classed as productive of teak, excluding a further area of 1,340 square miles that has not been definitely classified, but the majority of which is undoubtedly teak forest.

The following areas of different types of forest show how relatively small in importance is any other forest as compared with the teak forest:—

	Sq. miles
Indaing ...	142
Deciduous without teak ...	165
Evergreen without teak ...	265
Ponzo, i.e. re-growth after *taungya* cultivation ...	261

At the same time the stocking of all the forests is very low indeed. From such working plans as have given sufficient information it is found that the average stocking per acre of trees of all kinds over three feet in girth is 16·4 to the west of the Yomas and 17·9 to the east of the Yomas.

The following statement gives the relative density percentages of the more important and valuable species:—

Species	Relative density per cent. based on trees over 3 feet girth only.	
	West of Yomas.	East of Yomas.
Teak ...	16 per cent.	11 per cent.
Pyinkado ...	15 per cent.	21 per cent.
Pyinma ...	2 per cent.	1 per cent.
Kanyin ...	Under 1 per cent.	1 per cent.

No other species attains a relative density of one per cent. Roughly, therefore, it may be stated that under one-third of the stocking of just over seventeen trees over three feet in girth per acre is made up of teak and *pyinkado* and that the remaining two-thirds are made up of a very large number of different species, many of them of but very little value.

The total number of teak trees estimated is:—

6 ft. to 7 ft. girth	...	861,344
over 7 ft. girth ...	...	938,842

This may be taken to be the exploitable timber available. An estimate of the total volume is 4,179,177 tons and at Rs. 25 per ton *in situ* the value would be nearly Rs. 10½ crores (about £7,000,000).

There are estimated to be 9,692,790 *pyinkado* trees over three feet in girth but the greater portion of these cannot at present be considered available for extraction owing to the distance from lines of communication, as the timber, unlike teak, cannot be floated.

5. *The Dry Zone.*—The whole of the out-turn of the forest, which is mostly dry scrub characterized by *cutch* (*Acacia Catechu*) with *than* (*Terminalia Oliveri*), and *dahat* (*Tectona Hamiltoniana*) on slightly higher ground, is required for local consumption and the forests are of no commercial importance.

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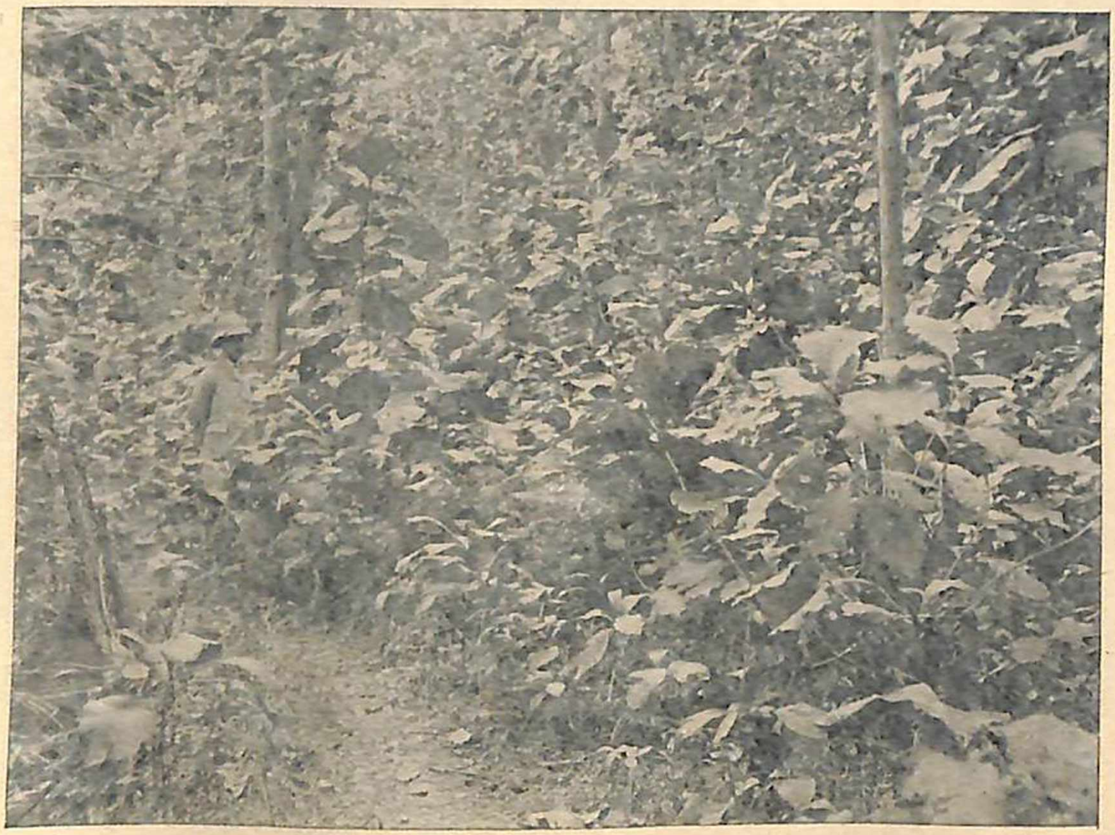
Plate IX.



Natural reproduction of teak, the great timber tree of Burma.

6. *The Upper Irrawaddy.*—With the railway and the Irrawaddy running through this range, a considerable area of the forest is rendered accessible. The most noteworthy forests for commercial exploitation are the large areas of *indaing* forest lying along the main Irrawaddy and some of its tributaries. These forests are characterized by a predominance of *in* (*D. tuberculatus*) which is usually found pure, the only example of pure natural forest in Burma. *Ingyin* (*Pentacme suavis*) is also found in some parts of these forests. Roughly there are 500 square miles of reserved forest mainly of this type in the range. Working Plans have already been made for 289 square miles. One of these gives an estimate of 34 tons per acre for the best class *in* forest. Working Plans for the remaining forests of this type are being compiled.

On the hills considerable areas of deciduous forests with teak are found. *Pyinkado* and *padauk* are only found in the south of this range but *taukkyan* (*Terminalia tomentosa*), *kanyin* and *ingyin* are found in some quantity. Further north and towards the east the deciduous forest gradually gives way to evergreen forest on the hills and the northern limit of teak is reached at Myitkyina.

Working Plans have been compiled for 1,461 sq. miles of the hill type of forest and deal mainly with teak. Such figures as are available show that the amount of *pyinkado* and other species of commercial importance is even less than in the forests of the Pegu Yomas.

EASTERN ZONE

7. *East Sittang.*—The only forests of value are those along the foothills east of the Sittang. These are mainly deciduous, varying from *indaing* of good quality to bamboo forests with teak, *pyinkado* and *padauk*. Further up the hills the deciduous forest gives way to evergreen, but the hills themselves have been so heavily cut over by the Karen *taungya* cutters that the forests are of little commercial importance. Except for the forests on the edge of the plain the country is extremely difficult and

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the cost of working timber other than teak is very high. Working Plans have been compiled for only 86 square miles.

8. *Shan Hills.*—These include the foothills in Meiktila and Maymyo divisions, which are mainly covered with deciduous forests containing teak, *pyinkado*, *padauk* and other valuable species such as *taukkyan* and *hnaw* (*Adina cordifolia*). Owing to the existence of the Southern Shan States and the Maymyo-Lashio branch railway lines the forests adjacent are exploitable and are being worked. In the Shan States the forest varies from oaks to pines (*P. Khasii*), but the latter are usually only found in the less accessible areas. Teak is found only in the valleys. Except near the existing railways it is doubtful if there can be much commercial working of timber in this range. Only one Working Plan has been made for 121 square miles for teak and no estimate of the stock is available.

9. *Moulmein.*—The forests are mainly of the moist type and range from moist deciduous with teak and *pyinkado* to evergreen characterized by Dipterocarps of several species. The teak forests are mainly confined to the valleys of the Salween and Thaungyin. Working Plans have been made for teak selection for 462 square miles in the Thaungyin valley of which 226 square miles are classed as teak forest. The area of the forest accessible to the extraction of timbers other than teak and available for commercial supply is somewhat limited and is confined to the lower Salween and the Ataran. A Working Plan is now being compiled for Ataran forests but valuations show them to be very poorly stocked with valuable species.

10. *Tenasserim.*—Very little exploration has been done in these forests, which have practically never been worked. There are very large areas of evergreen forests containing magnificent Dipterocarps and other large trees, the possible yield per acre being roughly computed at 35 to 45 tons, which is two or three times as great as anything in the rest of Burma. The evergreen forest is however reported to be patchy and intermixed with bamboo forests of less value. Nevertheless it

would appear that these forests offer by far the most promising opportunity for commercial working on a large scale in Burma. A recent rough valuation of the Ugawun Reserve gave an estimate of 38 tons to the acre over 250 square miles.

Present value, and value of output, and uses.

Timber and fuel.—The total out-turn for Burma for the year 1921-22 may be roughly summarized as follows :—

KIND	Volume	Value
		Rs
Teak	601,100 tons at Rs. 80	4,80,88,000
Other reserved timbers ...	263,080 ,, ,, 40	85,23,200
Unreserved timbers ...	453,220 ,, ,, 30	1,35,96,600
Fuel	1,065,620 ,, ,, 10	1,06,56,200
Total ...	2,383,020	8,08,64,000

The above values have purposely been placed very low.

The following shows the timber exported from Burma during the year with value for customs purposes. Much of this timber is of course converted.

Teak	176,083 tons valued at	...	Rs. 2,91,40,238
Other timber ...	34,959 ,,	...	,, 36,51,146
Total ...	211,042 tons valued at	...	Rs. 3,27,91,384

The bulk of the teak and practically the whole of the other timber exported went to India. The timber other than teak was mostly exported in the form of sleepers.

Minor produce.—The total estimated value of minor produce extracted during 1921-22 was Rs. 13,85,072.

This included the following main items :—

Bamboos ...	27,901,000 valued at ...	Rs.	3,08,365
Canes ...	35,802,000 ,, ...	,,	32,791
Cutch ...	2,688,295 viss valued at ...	,,	1,15,513
Lac	1,834,826 ,, ...	,,	3,52,539
Grazing (largely value of grazing by right-holders)	8,534,826 head grazing fees valued at	,,	3,60,064
Thatching materials	3,332,165 pieces valued at...	,,	67,415
Indwe pwenyet ...	66,421 viss valued at ...	,,	7,582
Thitsi ...	233,723 ,, ...	,,	27,264
Shaw fibre ...	262,658 ,, ...	,,	6,708
Edible birds'-nests valued at	... ...	,,	8,000

In most cases the actual duty, or the value of the duty where produce is supplied free, has been allowed. The actual value of the produce would obviously be far higher.

Revenue.—The total revenue from all sources for the year 1921-22 was Rs. 2,21,16,786. In addition produce to the duty value of Rs. 6,63,573 was given away free to right-holders or free grantees.

Further possibilities of development and increased output.—The main obstacle to the development of the forests of Burma may be stated very briefly as '*tonnage per acre.*' The paucity of communications has really little to do with the question. Admittedly increased communications make for an increased output but the possible yield from the forests alone cannot usually justify the expenditure of the capital necessary before exploitation can be commenced. Roughly speaking, the volume of timber over three feet in girth of all species does not ordinarily exceed 15 tons per acre and there are thousands of square miles of forest that will not even yield this amount. Teak, the most valuable product, can, and probably always will, be extracted more cheaply by floating, and the balance of the stock will not pay for the cost of communications necessary for exploitation. That communications such as roads or even railways would pay in the long run in many of our forests is probable, but the return on the capital is necessarily so slow, the benefits to be attained having a value to the community and posterity rather

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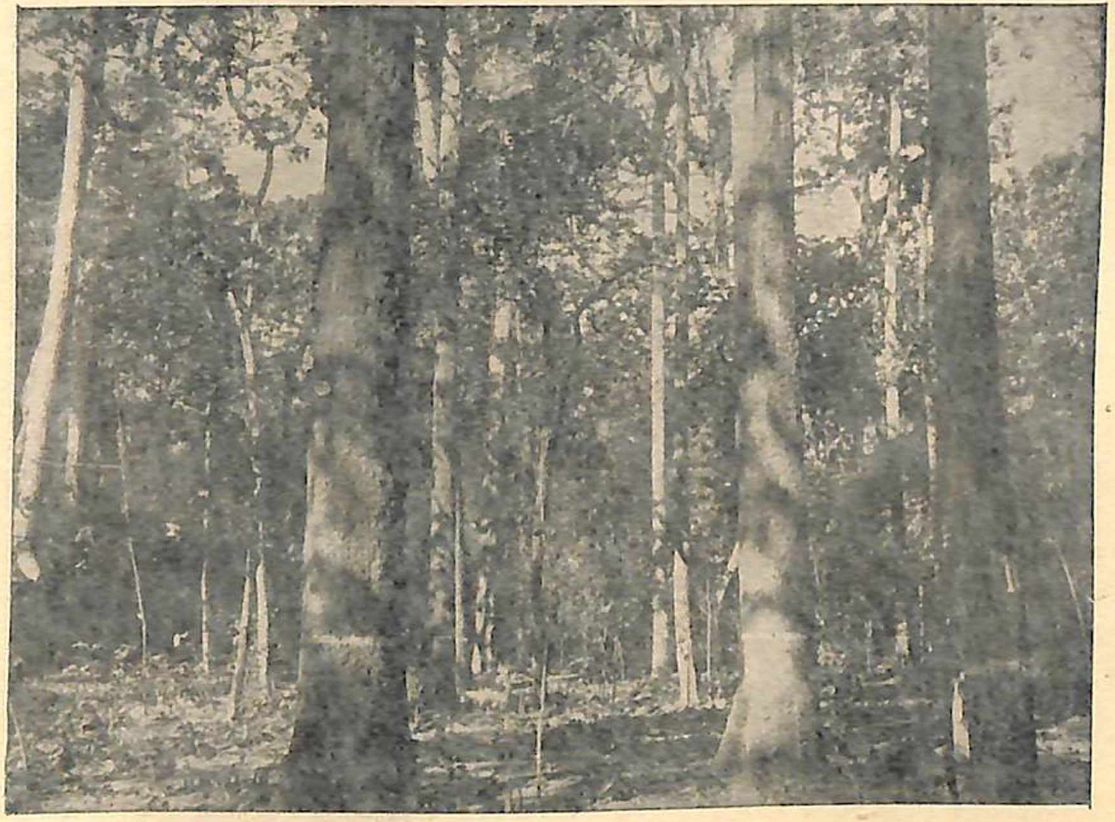

Fine *Dipterocarp* forest, Toungoo, Burma.

74

than an early return in money, that exploitation of the greater portion of these forests by the sinking of capital in communications cannot be considered a commercial undertaking. A few areas such as the evergreen forests of Tenasserim and the *indaing* forests of Upper Burma are possible exceptions and as the valuation of the stock proceeds other suitable areas may no doubt be found, but the above remarks apply to the bulk of the Burma forests.

The output of teak timber has probably now reached its maximum. Increased revenue will come from better royalty rates rather than from increased out-turn. With regard to timbers other than teak the best method of increasing the output is to take steps to secure an export market and to improve the method of extraction, conversion and seasoning. Thus by increasing the demand for, and incidentally the value of, the Burma products the outlay of capital on communications can be more fully justified.

It is probably with regard to minor products that the most rapid expansion of output lies. These have been much neglected in the past but with improved communications and fuller knowledge of the stock available, it is probable that the extraction of minor products will increase very rapidly.

8. THE FORESTS OF THE ANDAMAN ISLANDS

The Andaman forests resemble those of Burma in general features; they differ to some extent in individual species, though many species are identical. The climate of the Andamans is warm and equable. The rainfall at Port Blair is 118 inches, but judging by the aspect of the forests it is probably somewhat less in the North Andaman. Troup has classified and described the main types of forests in the Andamans as follows :—(*a*) Mangrove forests, (*b*) beach forests, (*c*) evergreen forests, (*d*) semi-evergreen and deciduous forests, and (*e*) diluvial forests.

(*a*) *The mangrove forests* are of the usual type of mangrove swamp on muddy flats between high and low tide limits at the mouths of creeks and in sheltered backwaters. The outer limit of the mangrove swamp, nearest the sea, is composed mainly of *Rhizophora mucronata* and *R. conjugata*, while farther from the sea these species gradually give place to *Ceriops Candolleana*, *Kandelia Rheedii*, *Bruguiera gymnorhiza*, *B. parviflora*, *Carapa obovata*, *C. moluccensis*, *Gynometra ramiflora*, *Lumnitzera racemosa*, *Sonneratia acida*, and other species. On the banks of creeks or in places farthest from the sea and only reached by the highest tides are found *Heritiera littoralis* and *Aegiceras majus*.

(*b*) *Beach forests* take the form of comparatively narrow strips along raised beaches of sand, shell, and coral above high-tide limits. Among the commoner trees and shrubs of this type of forest are *Mimusops littoralis* which sometimes forms pure belts, *Calophyllum Inophyllum*, *Terminalia Catappa*, *Erythrina indica*, *Pongamia glabra*, *Heritiera littoralis*, *Thespesia populnea*, *Afzelia bijuga*, *Hibiscus tiliaceus*, *Odina Wodier*, *Pandanus* spp., and *Ximenia americana*.

(*c*) *Evergreen forests* are confined for the most part to the ridges and upper slopes of the hills. In the South and Middle Andamans their distribution is further determined by the presence of micaceous sandstone which favours the growth of this type of forest. The most characteristic trees of the evergreen forests are several species of *Dipterocarpus*, including *D. turbinatus*, *D. alatus*, *D. incanus*, and others, *Hopea odorata*, *Planchonia andamanica*, *Artocarpus Chaplasha*, *A. Lakoocha*, *Mesua ferrea*, *Myristica Irya*, *Calophyllum spectabile*, *Albezzia Lebbek*, *Diospyros Kurzii*, and *Podocarpus neriifolia*. There is a dense undergrowth of canes and other climbers, including the climbing bamboo *Dinochloa andamanica*.

(*d*) *Semi-evergreen and deciduous forests* occupy as a rule the lower slopes and undulating ground between the mangrove or beach forests and the evergreen forests, but in the South and Middle Andamans their distribution is also determined by the geological formation, since they are found almost entirely on metamorphosed and indurated clay and shale, conglomerate, quartzite, limestone, and hard coarse-grained sandstone. On hot southerly slopes these forests become typically deciduous, but elsewhere they are commonly of a semi-evergreen character. The most important timber tree of these forests is the padauk (*Pterocarpus dalbergioides*), and with it are found *Lagerstroemia hypoleuca*, *Terminalia bialata*, *T. Manii*, *Albizzia Lebbek*, *Bombax insigne*, *Odina Wodier*, *Sterculia* spp., *Careya arborea*, and *Adenanthera pavonina*, as well as many of the trees of the evergreen forests. The undergrowth consists mainly of shade-bearing shrubs and small trees, with some palms and canes, but it is not so dense and impenetrable as in the evergreen forests.

(*e*) *The diluvial forests* occur on diluvial deposits of deep, sandy soil lying between the mangrove forests and the hills. They contain trees of both the evergreen and semi-evergreen types, including *Dipterocarpus* spp., *Lagerstroemia hypoleuca*, *Bombax insigne*, *Terminalia bialata*, *T. Catappa*, *Sterculia alata*, and *Pterocarpus dalbergioides*. There is a dense impenetrable undergrowth of climbing bamboo, canes, and creepers, but as the mangrove swamps are approached the bamboos and canes disappear and the undergrowth consists largely of palms such as *Phoenix paludosa*, *Licuala* and *Areca triandra*, while littoral species of trees such as *Heritiera littoralis* and *Cynometra ramiflora* make their appearance.

The commercial value of the Andaman forest lies almost entirely in the facilities for export of the timber to Calcutta and London and other markets overseas, since the local demand is practically negligible. The *padauk* (*Pterocarpus dalbergioides*) is the principal timber tree of the Andamans, its beautiful red wood being highly esteemed for furniture, panelling, and interior building or decorative work generally: it has gained a footing on the European and American markets, and is in considerable demand. Other important timbers are *pyinma* (*Lagerstroemia hypoleuca*), *gurjan* (*Dipterocarpus* spp.), white *chuglam* (*Terminalia bialata*), *koko* (*Albizzia Lebbek*), etc. The extraction of the timber is carried out almost entirely by departmental agency, and two large saw mills, one in the south island, and one in the north island, have been erected. The different timbers are sent in the form of rough hewn or sawn squares and scantlings to Calcutta and London, where they are sold through the agency of Messrs. Martin & Co. (Calcutta) and W. W. Howard Bros. (London). The development of forest activities in the Andamans affords a typical illustration of the difficulties of management of mixed tropical forests. In these mixed forests, out of the score or more of large timber trees, only the four or five species mentioned above are saleable, and there is no demand for other species and smaller sized trees. This necessarily results in extensive areas being worked under the selection system, and the removal of a tree here and a tree there. An attempt was made to introduce more concentrated fellings, with artificial regeneration of the clear felled areas, and in the years 1916-21 when convict labour was available, some satisfactory plantations were made in this way. But later the convicts were withdrawn, there was absolutely no labour available (an attempt to introduce karens from Burmá did not materialise), and consequently no plantations have been made since. The accessible coastal forests have been heavily worked for *padauk*, and to facilitate its extraction from the inaccessible inland forests, a scheme of extraction by metre gauge railway has been started, but the scattered nature of the fellings naturally increase extraction costs.

The total area of forest in the Andamans is 2,200 square miles, but only a comparatively small portion of this total area is at the present time intensively worked. The annual output of timber (in the round) available for export exceeds 600,000 cubic feet, and this quantity can be, and will be, enormously increased, as conditions of demand and development of new markets permit.

Minor forest products are at present of comparatively small importance, as there has been no staff or spare time available to examine and develop them, but there are interesting possibilities, amongst which may be mentioned the crushing of seeds for edible or luminant oils, and fibres for the manufacture of ropes; while sources of supply of tannin extracts are extensive and entirely untouched, the Dipterocarp oils are very little used, and nothing is done with the very plentiful resin of *Canarium emphyllum*. In short, the forests of the Andamans have considerable potential value, and in time and with the return of normal trade conditions should show very fine financial results.

CHAPTER V

MINOR FOREST PRODUCE

INDIAN forests are exceptionally rich in a large number of minor forest products, and, apart altogether from their importance for the production of timber and fuel, for the supply of grass and grazing, and for meeting the miscellaneous requirements of the great agricultural population, they have an additional importance in supplying the raw produce on which a number of important industries are based. A detailed consideration of the many important industries, unconnected with timber but dependent on the forests, would fill a large volume; all that can be done here is to review shortly a few of them by way of example.

1. THE INDIAN PINE-RESIN INDUSTRY

The commercial[1] exploitation of the resin of the Indian pines serves a wide range of subsidiary industries. It provides resin for shellac making, soap manufactures, paper concerns, oil-cloth, linoleum, sealing wax, printing inks, electric insulation, gramophone records, and wheel grease. And it also provides turpentine, which is the chief thinner and solvent employed in the paint and varnish trades, a mordant in print goods manufacture, the basis of synthetic camphor, and an ingredient of boot polishes, embrocations and liniments. The field is wide enough in peace time, but was considerably expanded in war time by the rosin used in 'setting' shrapnel bullets in shells.

Of the world's trade in rosin and turpentine or 'naval stores' the United States of America command 80 per cent. of the output, France coming second with some

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[1] *The Work of the Forest Department in India*, April, 1920.

15 per cent. and the rest of the world taking the remaining 5 per cent.

It is now well over a quarter of a century since forest officers in the North-West of India began to realize the potentialities of the wide pine belt along the foot-hills and lower slopes of the Himalaya. Many of them being French-trained, it was not surprising that the splendidly organized tapping of the maritime pine of the Landes should serve them as a model, and so from the very start the conservative cup and lip method in use in France was adopted, thus ensuring the best possible yield of resin with the minimum risk of injury to the tree. And so from small beginnings in the United Provinces and later in the Punjab the industry has grown till now it has reached very considerable proportions.

Since 1912 both in the United Provinces and the Punjab extensive and successful organization has brought the harvesting of the resin to a high state of efficiency.

It was in the factories and in the selection and devising of manufacturing methods best suited for the distillation of the Indian pine resin that the Forest Department found its hardest task, a task in which the Forest Research Institute at Dehra Dun and the Imperial Institute, London, gave much helpful advice and assistance. America, thanks to the happy chemical constitution of its principal pine resin, produces a turpentine which stands in a class by itself, though manufactured in the most primitive, direct fire-heat apparatus. French manufacturers found, but not till they had learnt by bitter and costly experience of adverse trade criticism and adverse markets, that an apparatus good enough for America was not good enough for the maritime pine-resin of the Landes, and so, since 1900 or thereabouts, technical French engineers at Bordeaux, energetically assisted by the chemical section of the Bordeaux University, have devoted much attention to the subject of resin distillation. The result has been a score or more of patents, in all of which fire heat is eliminated and complete control of temperature is maintained by systems of steam heating and steam injection. France has thus been enabled to do the best with its pine resin and produces rosin with a good reputation in the trade and thoroughly sound mercantile turpentine.

The lesson learnt in France gradually penetrated to India. The primitive stills first used in the United Provinces and the Punjab were re-modelled and modified till now both provinces possess batteries of stills of the best French type, steam-operated and modified to suit Indian conditions, which are giving entire satisfaction by the excellence of their products.

There is no need here to enter into a detailed description of the method of tapping and collection of the crude resin (a detailed account is given in *Forest Bulletin* No. 26, 1914) or of its distillation and purification. The possibilities of development of the Indian pine-resin industry are considerable. The average annual consumption of 'naval stores' in India based on statistics for the financial years 1907-08 to 1918-19 was, for rosin 89,119 maunds, and for turpentine (including turpentine substitutes) 245,729 gallons. In 1907-08 the Indian factories produced 6,609 maunds of rosin and 16,086 gallons of turpentine, and in the intervening twelve years have succeeded in increasing their output tenfold, imports of American origin decreasing proportionately. At present the resin industry is practically in the position of having to retard or accelerate its expansion with direct reference to the speed with which the remainder of the Indian market can be secured and outside markets such as Java, China, etc., developed. It is here that closer co-operation with the trade interests of India is necessary and more active measures have to be adopted to advertise Indian rosin and turpentine. The industry is, therefore, one to which in recent years the Forest Department has rightly devoted a good deal of attention, and though expansion must be gradual, yet the prospects are there, and it only requires effort along sound commercial lines to reap a good harvest. Any forest industry which yields such satisfactory financial results and yet leaves the main source of forest wealth, namely the timber, a realizable asset, is deserving of the most careful study.

Commercial production may be considered to have started in 1907 and from that date progress has been fairly steady as the following table shows :—

IMPORTS INTO, AND PRODUCTION IN, INDIA, OF ROSIN AND TURPENTINE SINCE 1907

Year April to March	Rosin			Turpentine		
	Imported	Indian production	Total cwts.	Imported including substitutes	Indian production	Total gallons
1907–08 ..	76,200	4,845	81,045	225,560	16,086	241,646
1910–11 ...	41,600	6,625	48,225	197,720	17,051	214,771
1913–14 ...	45,769	20,100	65,869	193,937	58,803	252,740
1916–17 ...	18,760	43,500	62,260	80,000	125,663	205,663
1919–20 ...	13,855	46,700	60,555	113,638	148,680	262,318
1921–22 ...	10,602	57,200	67,802	70,369	163,151	233,520
1922–23 ...	*18,037	82,000	100,037	*90,364	279,100	369,464

*Imports for the calendar year 1922

The year 1913-14 was the first year in which a really serious attempt at sound commercial production was made and nine years later (1922-23) production had increased four-fold.

The above figures also indicate that in the case of rosin, the Indian market, which may be considered as capable of absorbing about 70,000 cwt. yearly, has been captured to the extent of about 80 per cent. and that an appreciable proportion of the Indian production is available for export.

As regards the turpentine figures, it should be noted that the import figures include turpentine substitutes (in 1922-23 amounting to 50 per cent. of the imports) with which it is hardly possible to compete. The present Indian consumption of genuine turpentine is approximately 200,000 gallons, and it was not until 1922 that Indian production exceeded Indian demands.

India is therefore in a position to export appreciable quantities of both rosin and turpentine, and, as a matter of fact, has already made a good beginning as is shown below :—

EXPORTS OF ROSIN AND TURPENTINE FROM INDIA

YEAR	Rosin (cwt.)	Turpentine (gallons)
1918-19 ...	...	...
1919-20 ...	9,731	...
1920-21 ...	8,102	300
1921-22 ...	1,595	995
1922-23 ...	30,000	5,000

In brief, at the present moment, the Indian market has been almost completely captured and sound export connections have been established. This has virtually been accomplished within nine years.

The Great War illustrated the supreme advantage of an indigenous resin industry, and at a time when rosin and turpentine were quite unobtainable from America and France the United Provinces and the Punjab distilleries were the salvation of local industries and munition works. Unfortunately in 1921, in certain parts of the Punjab and over a considerable part of the United Provinces, this successful and profitable industry received a serious set-back. In the political ferment that arose with the introduction of elective and democratic principles of Government of the country, in the rise of the non-co-operation movement and the preachings of Mahatma Gandhi, agitators found the opportunity to do incalculable but senseless damage to the pine forests, which were swept by incendiary fires almost from end to end, and the excellent results of careful nursing and protection of decades were wiped out in a week, and owing to the death or weakened condition of scores of thousands of trees, resin tapping had temporarily to be abandoned over extensive areas. It has been pointed out in a previous chapter that no one benefits from the resin industry in India more than the local hillman, and it is a pitiful commentary on the effects of this unfortunate political agitation that it should result in such wanton damage to an industry which is so helpful and advantageous to the local people, apart from the benefits it gives to Government, to the general tax-payer and to important industries. India is the one and only country in the whole of the British Empire that is producing these two important materials, rosin and turpentine, on a large scale.

2. The Paper Pulp Industry

In India[1] the manufacture of paper is a well established if not a large industry; it dates back some fifty years and is carried on side by side with that of paper pulp, differing in this respect from the practice in force in Europe and America, where the two form entirely separate industries. This state of affairs is due to the difficulty of preparing either mechanical or chemical wood pulp in India, for though suitable species of timber are obtainable, it is doubtful whether the quantity available is sufficient to keep a pulp industry going permanently, it being recognized that the timber requirements of the country must have first claim on the available timber supplies. To overcome this difficulty the paper maker has had to resort to importing woodpulp, which is expensive, and to preparing his own half stuff from grass and waste products, thus combining the art of paper making with that of preparing pulp from indigenous raw materials.

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[1] *The Work of the Forest Department in India.*

In 1904, there were eight paper mills in British India and Indian States, with an output of 20,100 tons of paper annually, the daily average number of persons employed being 4,266. In 1918, the number of mills had increased to nine, the output to 31,363 tons, and the average number of operatives employed to 5,759.

The present demand for paper is supplied by the nine mills referred to, by imports, and to a very small extent by hand-made paper prepared locally. The import of paper and pasteboards into India in 1918-19, exclusive of note paper and envelopes, amounted to 21,638 tons, valued at £1,487,022, or including note-paper, at a total of £1,813,779.

Turning now to the question of paper pulp, we find that India imported no less than 13,250 tons of pulp in 1912-13, that is, in pre-war times, while by 1918-19 the amount had fallen to 2,090 tons owing to the prohibitive cost of obtaining half stuff and to shipping difficulties. In spite of great difficulties in obtaining chemicals during the war, the Indian mills not only maintained their output but actually increased it, a fact strongly indicating the possibilities of expanding the output in this country, now that more normal conditions prevail.

The most important raw material used in India at the present day for the production of half-stuff is *sabai*, *bhabar* or *baib* grass (*Ischoemum angustifolium*), which is obtained from the forests of Bengal, Chota Nagpur, Orissa, Nepal and the United Provinces. The other materials used in India for the manufacture of paper are rags of poor quality, hemp, jute, gunny bags, waste paper and old ropes. Since the war began, limited quantities of *munj* grass (*Saccharum Munja*), have been used, though the yield of pulp from this grass is not high, while in many parts of the country its value is considerable owing to the demand for other purposes.

The two most important substances from which pulp is prepared all over the world are wood and grasses of which wood claims 90 per cent. of the out-turn. In India, owing to the large number of species and the

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generally mixed character of the forests very few timbers are available which fulfil the necessary conditions to ensure the success of a pulping concern, namely, concentrated large supplies coupled with suitability for the manufacture of pulp. The few timbers that meet the above conditions are not available for pulp as the timber is required as timber in the ordinary development of the country.

Under the natural order *Gramineae* we have bamboos and grasses, both of which are available in large quantities in certain localities of British India, and some of which have, from experiments, given very favourable results. Up to date the best results have been obtained with *Bambusa polymorpha* (*kyathaungwa*), a species which occurs in great abundance in Burma. *Cephalostachyum pergracile* (*tinwa*) and *dendrocalamus strictus* (the common male bamboo) have given almost equally good results, while *Bambusa arundinacea* (the thorny bamboo) and *Melocanna bambusoides* (the single-stemmed bamboo) have given results little inferior to the best as yet obtained. All these species are available in very large quantities and can be extracted at relatively cheap rates. A complete note has been published by the Forest Research Institute printed on pure bamboo paper, giving figures of out-turn, cost of extraction, suitable localities in which to erect factories, cost of manufacture and the results obtained based on tests carried out on a commercial scale. The scheme for making bamboo-pulp has now been taken up by several firms, leases having been granted by the Forest Department in Burma, Chittagong and Bombay, and consequently the manufacture of pulp from bamboo is an accomplished fact.

The elephant grasses found in certain localities of India and Burma afford material nearly as promising for the manufacture of pulp as that yielded by bamboos. According to Mr. W. Raitt, the cellulose expert, those grasses which yield the best pulp are, in order: (1) *Anthistiria gigantea* including the two sub-species *A. arundinacea* and *A. villosa*, (2) *Phragmites Karka*, (3) *Saccharum Munja*, (4) *Saccharum arundinaceum* and *Saccharum narenga* bracketed, (5) *Saccharum spontaneum* and (6)

Arundo Donax. Recently experiments on a commercial scale were made with *Saccharum spontaneum* and *Saccharum narenga* grasses obtained from Assam, resulting in the manufacture of several tons of paper prepared from each species; both species gave good results, the former especially making up into a very fair grade of paper. The possible out-turn of these grasses is very large, especially from Assam, Bengal, the United Provinces and Burma, while the cost of extraction is moderate. A note on the laboratory experiments carried out by Mr. Raitt with a preface by Mr. R. S. Hole, the Forest Botanist, gives valuable information as to the possibilities of elephant grasses for the manufacture of paper pulp.

The enormous available supplies of bamboos and elephant grasses could therefore be utilized for the manufacture of the 50,000 tons of paper and pasteboards which India imported prior to the war. It is true that neither bamboo nor grass pulp could be made to meet all requirements, since certain classes of paper cannot be made from these raw materials; nevertheless looking to the figures of cost of manufacturing bamboo and elephant grass pulps, there is no doubt that a large proportion of Indian requirements could be met from this class of pulp. Again the commercial prosperity and the diffusion of education in India justify the belief that the requirements for paper will rapidly increase in the near future. Moreover everything points to the future possibility of exporting pulp from India, but to the East rather than to the West, and Mr. Raitt, the cellulose expert, has left it on record that 'it is a modest estimate to say that from bamboo and savannah grasses, taking only that which is available under possible working conditions, India could produce ten million tons of pulp per annum.' With the value of chemical paper pulp at £16 to £18 per ton, the enormous potential value of this industry in India can be appreciated.

3. TANNING MATERIALS

India is exceptionally rich in tanning materials, consisting of the bark, fruits, or leaves of numerous trees

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and shrubs scattered about in the Indian Forests. A brief account of the more important of these tanstuffs will be given.

(1) *Myrabolans.*—These easily occupy pride of place as the most valuable and important tanstuff in India. The myrabolan is the fruit, or, as it is often incorrectly called, the nut, of the forest tree *Terminalia Chebula* ; it is usually collected while still green on the tree, and promptly dried in the sun. The ordinary commercial product, *jungle hurra*, of the central parts of India averages about 28 per cent. of tannin. If rotted fruits are removed, the average rises to 30 per cent. If when the fruit falls, or is beaten down from the tree, each fruit is broken and stones removed, the clean, dry flesh will carry as much as 52 per cent. tannin. The bulk of useful product is thus reduced to one-quarter, while the weight is reduced to 40 per cent. of what is usually carted and moved by rail. But the European tanner, having been frequently swindled by those who mixed in sand and the beleric myrabolan in crushed myrabolans, often insists on getting the uncrushed fruit, a striking commentary on the folly of dishonest practices. In Europe myrabolans are the best known Indian tanstuff, and find a very wide application in mixture tannages. In India myrabolans are largely used in mixture tannage, and perhaps still more largely as a 'bleaching' agent at the end of the tanning process. This is especially the case in the tannage of 'crust' leathers tanned with *babul* bark, when the tannage is completed by a bleaching process in a brew of myrabolans. For this purpose myrabolan extract would not be suitable, but in mixture tannages extracts could be utilized to replace the myrabolans at present used. For tannery use myrabolans should be crushed before extracting the liquors.

Myrabolans have also long been known as a dye-stuff. They are, for instance, used in Bombay for the production of yellowish-buff shades on cotton. Myrabolans also find some application in the manufacture of inks which are produced by the addition of iron salts, suitable gum, and some 'soluble blue' dye. In Europe myrabolans are used in the dye-house for the mordanting of cotton as a preparation for the application of basic dyes, the weighting of black silk, etc.

The quantities of fruits produced by the trees vary enormously in different years, and the available supply in one year may be several times the corresponding supply in the following or preceding year. This factor naturally gives scope for considerable gambling in the business of myrabolan collection. By far the greater part of the myrabolan crop comes from privately-owned forests, and very little is being done in India generally to increase the supply of *hurra* trees. The following figures are interesting, as indicating the importance of myrabolans as an article of export to foreign countries, (and it must be remembered that a very appreciable proportion of the total crop of myrabolans is used in India itself):—

EXPORTS OF MYRABOLANS FROM INDIAN PORTS

Destination	1919-20		1920-21		1921-22	
	Quantity	Value	Quantity	Value	Quantity	Value
	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.
British Empire ...	10,21,000	5,983,000	3,45,000	1,908,000	4,02,000	1,874,000
Rest of the world..	8,37,000	4,148,000	4,48,000	2,170,000	8,37,000	3,992,000
Total Exports ..	1,858,000	10,131,000	793,000	4,078,000	1,239,000	5,856,000

The figures show that myrabolans are an important article of commerce which is used in almost every tannery in the world (except of course in chrome tanneries). Their importance is due to the high percentage of tannin extract available and to their properties of decolourising and softening leather, which distinguish them from most of the tanstuffs described below, the latter being of importance in India itself, but of relatively small value for export.

(2) *Babul bark.*—One of the most widely distributed trees in the northern dry zones of India is the *babul*

(*Acacia arabica*), and the bark from felled trees has constituted possibly the most important tanstuff of Northern India. In the big tanneries of Cawnpore in the boom years of the War, over 20,000 tons of *babul* bark were used annually. The average tannin content of the bark is 12 per cent. while twig bark is poor, 7 per cent. The history of this tanstuff contains an important lesson. When the tanning industry started in Cawnpore the whole surrounding country was full of *babul*. The earliest supplies were sold for 8 annas per maund or less, and as soon as the demand increased there were those who developed business in the sale of timber, thus helping to realize better values from the trees and keeping down the price of the bark. For many years the price of bark remained at about 12 annas. As gradually the whole of the neighbouring country was stripped the price rose to Re. 1-4-0 just before the war. Then when the tanneries were suddenly called upon to turn out enormous quantities of leather, it was found that there were no supplies of *babul* in sight. (It may be noted that *babul* is one of the principal species being introduced in the Jumna ravine plantations described in Chapter III.)

(3) *Cassia auriculata bark—Turwad.*—This well-known tanstuff is used in very large quantities in the south and west of India, a rough estimate in the boom war year 1918 putting the annual consumption at 30,000 tons. The shrub grows wild in the south and west of India. When two or three years old the twigs which spring from the roots are cut down, and the bark stripped off and dried. Numerous coppice shoots spring up from the root and in a year or two another harvest can be taken. The average price for *turwad* bark may be put at Rs. 100 per ton. Extensive experiments were made in 1916-19 to introduce this shrub in the Jumna ravine plantations and forests in the United Provinces and elsewhere, but these have to a great extent failed, the growth and quantity of bark produced being disappointing, possibly due to climatic conditions (the climate is very much drier and hotter than in its natural habitat).

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(4) *Mangroves.*—The general term mangroves is applied to a large number of different species of trees which grow in the ooze alongside the rivers and in the swamps of tropical forests. This ooze is generally submerged each tide to the depth of several feet and most of the mangroves build up a network of roots which raises the main stem almost, if not entirely, above the high water level. The trees grow in salt, brackish water, although some species are found where the water is almost sweet. Speaking generally, the barks of all mangroves contain more or less chlorides from the salt water. These chlorides are often found most largely on the surface of the bark owing to spurting and evaporation of salt water, but there is generally also a considerable proportion disseminated throughout the bark, forming a definite constituent thereof. The principal mangrove areas in India are the Sunderbans (the great delta of the Ganges and Brahmaputra rivers), the delta forests of the Irrawaddy in Bassein, on the Arakan coast, in Mergui and Tavoy, and in south-east Madras, and the principal species of trees are *Rhizophora conjugata*, and *R. mucronata* (*gurjun*), *Heritiera Fomes* (*sundri*), *Ceriops Roxburghiana* (*goran*), *C. Candolleana* and such species as *Carapas*, *Bruguieras*, *Sonneratias*. The tanstuff consists of the bark of the trees, which is stripped when the trees are felled, and dried. These barks contain roughly 8 to 12 per cent. of tannin. For many years the Indian Government ran an experimental factory in Rangoon, in order to test the commercial possibilities of making tannin extracts and concentrates from mangrove barks.

Other Indian tanstuffs available in the Indian forests are too numerous to describe in detail, and a few will be only briefly mentioned.

The bark of *sal* (*Shorea robusta*), and the bark and wood of *Shorea obtusa*.

The fruit of *ghont* or *gothar* (*Zizyphus xylopyra*), a common shrub occurring extensively in many of the drier parts of India.

The leaves of *dhawa* or Indian sumach (*Anogeissus latifolia*), the young pink shoots of which are especially rich in tannin.

The bark of *kahua* or *arjuna* (*Terminalia Arjuna*).

The fruit of *bahera* (*Terminalia belerica*), and *aonla* (*Phyllanthus Emblica*).

The barks of Himalayan oaks and chestnuts are comparatively rich in tanning material, but the difficulties of economic working of hill forests appear almost insuperable. A recent enquiry for a suitable factory site to utilize 2,000 tons of oak bark annually had to be abandoned for this reason.

For fuller details on Indian tanstuffs, the reader is referred to the bulletin (No. 1 of 1918) by Messrs. Fraymouth and Pilgrim.

4. ESSENTIAL OILS

In various parts of the forests of India, certain aromatic grasses occur, from the distillation of which valuable scented oils are obtained. These grasses belong to the genus *Cymbopogon* of the family *Gramineae* and have been classified as follows:—

1. *C. Martini* (rosha oil grass).
2. *C. Citratus* (lemon oil grass).
3. *C. Nardus* (citronella oil grass).

A brief note on each of these three grasses, and their present and potential value is given below.

(1) *Rosha oil grass.*—The plant has a wide distribution, being generally found in the drier hot forests and waste areas of India, and is of economic importance in the Bombay Deccan, the Central Provinces, and the Berars. There are commercially (but not botanically) two distinct varieties, i.e., *Motia* growing sporadically or in single clumps on the hottest slopes, and giving the best quality oil, and *Sofia* growing gregariously in cooler and moister localities and giving somewhat inferior oil.

The portion of the plant from which the oil is obtained is the flower and leaf, while only small quantities of the oil can be obtained from the stem itself. The flowers and upper third of the stem are collected in September and October and are tied into bundles or *pulas* of about a quarter of a pound each. Donald, in describing the

CSL

process of distillation in an article published in the *Indian Forester*, Vol. XXXIX, of March 1913, states that the inflorescences are cut twice, a second flowering occurring after the first inflorescence has been cut. The grass is either distilled in a partially green state or the flower heads and portion of stem are carefully dried in the shade before distillation, during which period they lose from about 20 per cent. to 40 per cent. of their weight according to the degree of dryness which they are allowed to attain before being treated.

The plant used by the local distillers is extremely primitive and consists essentially of a copper or iron still covered with mud and erected over an open fire near a stream or pond; from the top of the still a bamboo pipe leads the vapours given off to a condenser. The still is charged with 80 or 100 lb. of grass and 300 to 400 lb. of water, and the charge takes an hour and a half to three hours to complete. The quantity of oil obtained by this rough and ready method of distillation varies from 0·1 to 0·3 per cent. of the weight of air-dried grass distilled. In recent years the application of steam distillation (indicated by experiments carried out by the Forest Research Institute officers) has given much better results and is being extensively adopted.

The quantity of rosha oil produced annually in India varies from 100,000 to 130,000 lb., of which about 10 or 15 per cent. is used in the country itself and the balance exported, chiefly to Europe. The value of the oil in pre-war times was about Rs. 5 per pound and is now about Rs. 5-8 to 6 per pound. The value of rosha oil produced annually may thus be put at about £40,000.

(2) *Lemon oil grass.*—This grass grows wild in the South of India (Madras and Travancore), and it is also cultivated in fields. The method of collection and distillation is very similar to that of rosha oil described above, and need not be repeated. The lemon grass oil is the most important commercially of the three oils discussed in this note, and in addition to local consumption, the following figures of export show that it is an important article of commerce.

MINISTRY OF CULTURE · GOVERNMENT OF INDIA
GSL

Destination	1919-20		1920-21		1921-22	
	Quantity	Value	Quantity	Value	Quantity	Value
	gals.	Rs.	gals.	Rs.	gals.	Rs.
British Empire ...	11,148	3,28,910	1,798	71,680	6,496	1,38,383
Foreign Countries	19,809	6,23,540	37,928	15,51,620	37,241	7,80,046
Total Export ...	30,957	9,52,450	39,726	16,23,300	43,737	9,18,429

(3) *Citronella.*—This grass is also found both wild and cultivated. The collection and distillation of citronella oil is on a smaller scale than the two oils described above and thus it is of less importance commercially. The quantity exported in 1921-22 amounted to 10,000 gallons valued at Rs. 125,000.

The combined total of these three oils exported from India, and the value of this export trade is shown below (in round figures) :—

Oil	1920-21		1921-22	
	Quantity	Value	Quantity	Value
	gals.	Rs.	gals.	Rs.
Rosha ...	5,200	290,000	6,000	366,000
Lemon grass ...	39,800	1,623,000	44,000	918,000
Citronella ...	2,000	37,000	10,000	126,000
Total ...	47,000	1,950,000	60,000	1,410,000

With improved methods of distillation, of collection and cultivation, there is little doubt that the essential oil industry could be considerably and profitably expanded.

5. LAC

Lac is a resin and owes its importance in industry to the fact that in its manufactured form, shellac, it is the hardest known resin. Lac is an animal product and is

CSL

produced as a secretion by a species of minute scale insect or Coccid which sucks the juices of certain trees common in India. The individual secretions from so minute an insect (about one-fortieth of an inch long at birth) are of course very small but as the habit of the insect is to live in colonies on the twigs of trees and the individual insects pack very close together, the neighbouring secretions soon coalesce to form an incrustation of lac sometimes over one-fourth of an inch thick all round the twig when the lac is mature. This tiny insect is mauve in colour and perfectly formed with eyes, antennae, and three pairs of delicately-formed legs; the mouth parts are in the form of a proboscis adapted for piercing the bark of succulent twigs and for sucking the juices of the tree. On hatching from the eggs inside the shell of its dead mother, the insect crawls out of its mother's cell in the old lac and searches for a suitable succulent twig on which to make its new home. Having found such a spot it proceeds to dig in its proboscis and commences to suck the juices of the tree. As it has no further use for legs, eyes or antennae, the insect casts them off at the first moult and from then onward consists of a shapeless sac and a sucking proboscis at one end. Nothing much else is obvious about it except the breathing apparatus and the outward signs of a digestive apparatus. There are however a number of pore-like openings along each side of the body from which the lac is secreted. The insect's object in secreting this lac is not fully understood. All scale-insects make a protective covering or scale for themselves because their skins are very delicate but they are usually not on so generous a scale as in the case of the lac insect. The lac may also be in the nature of a waste product. The insect's object is, however, a matter of purely academic interest; what is of importance is that these tiny secretions have those remarkable properties that make lac the valuable article of commerce that it is.

The trees on which lac grows are *kusum* (*Schleichera trijuga*), *palas* or *dhak* (*Butea frondosa*), *ber* (*Zizyphus Jujuba*), *ghont* (*Zizyphus Xylopyra*), and *babul* (*Acacia arabica*) besides many others of less importance. *Palas*

GSL

closely followed by *ber* produces the largest quantity of lac, but *kusum* lac is of much superior quality, being about 30 per cent. more valuable than lacs from the other three species, which are approximately equal in value.

There are possibly several local varieties of the insect but this subject has not been worked out yet. There are usually two broods of insect in the year. Swarming, the emergence of the newly hatched insect, usually occurs twice a year. One brood swarms at the beginning of the rains, matures in November, dies and produces the second brood, which matures at the beginning of the rains. Consequently there are two lac crops each year and they vary both in quality and in quantity in different localities.

Lac is virtually a monopoly of India. It does grow in a few adjoining countries but the quality of such lac cannot compete with Indian varieties. The distribution in India is very irregular. The main area consists of Chota Nagpur, Orissa, the northern and eastern districts of the Central Provinces, parts of Baghelkhand and Bundelkhand, Sind, and a few districts of Bengal and the United Provinces. This area produces over 85 per cent. of the world's lac supply. Lac also grows on a commercial scale in restricted areas in the Punjab, Assam and Burma; and many attempts have been made with varying success to grow it in other parts of India. The factors which influence the distribution of lac cultivation are chiefly climatic, though railway communication also plays an important part.

Although there are only two lac crops proper annually yet the trade recognizes four. *Kusum* lac is of much finer quality and often somewhat later in maturing than that on other trees; hence its two crops have received separate names. The four crops are:—

Jethwi—The summer-rains crop from *kusum.*
Kusmi, *Nagoli*—The winter crop from *kusum.*
Baisakhi—The summer-rains crop from other species.
Katki or *Rangeen.*—The winter crop from other species.

The lac crops are further differentiated accordingly as they are collected before or after the swarming of the insect. *Ari* is lac collected before the insects have swarmed and consequently contains their dead bodies. *Phunki* is lac from which the insects have swarmed and is consequently clearer and purer than *Ari*. In its primitive stage the industry involved no artificial measures of cultivation, but consisted in merely collecting what lac grew wild and trusting to the small quantities overlooked by the collector to restock the trees by their offspring. This method is still practised in some of the less important lac areas.

A more useful method now is to leave a portion of the crop on each tree, usually the upper part. A brief study of the habits and life history of the insect is sufficient to show that this is not likely to be a very effective method. What appears to be the ideal practical method for lac cultivation is to concentrate work and to obtain as large a crop of lac as possible on a few trees, using a rotation among the trees, rather than to grow small crops continuously on all trees. This means that when the crop is about to swarm it must be cut and transferred to the new trees, the *phunki* lac being then collected after the insects have swarmed out onto the new trees. More labour, more skill, and more protection from theft are required to do this, though the organization of labour, supervision and protection from theft are rendered correspondingly easier by concentration. This method is now being experimented with on a large scale in Government forests both in Bihar and Orissa and in the Central Provinces, and in somewhat modified form has been practised for some years by small cultivators of lac in Manbhum and adjoining districts on *ber* trees round their homesteads.

Of the lac now marketed some five per cent. comes from Government forests, and perhaps five per cent. from areas leased by big cultivators. The rest is entirely in the hands of petty cultivators who practise it as a subsidiary means of livelihood. High caste Hindus are prejudiced against the industry on the ground that it involves taking the life of the insect and therefore the cultivators are mostly of low caste or aboriginal and consequently usually quite uneducated. This prejudice is gradually disappearing as the material profits from the lac industry make themselves apparent.

A serious obstacle to the extension of lac cultivation is the risk of petty theft; this is obvious when a pound of lac may be worth one rupee. The lac crop matures in value about a month before the larvae are ready to emerge. The petty cultivator, always fearful of theft, is often induced therefore to cut his lac early and sell it before the insects emerge rather than run the risk of losing all during some dark night, trusting to be able to buy his brood requirements elsewhere at some later date.

The principal districts producing lac are:—

In Bihar and Orissa: Manbhum, Ranchi, Hazaribagh, Gaya, Palamau, Sonthal Parganas and Singhbhum.

In the Central Provinces: Bilaspur, Raipur, Bhandara, Damoh and Jubbulpore.

In other provinces: Hoshiarpur (Punjab), Rewah and other Central India States, Hyderabad (Sind), Malda and Murshidabad (Bengal).

The scattered character of the lac industry and the fact that it is mostly situated in wild jungly places has resulted in the growth of a complicated system of trade in order to collect the raw product from its hundreds of thousands of cultivators and place it in the hands of the manufacturers. The outposts of the trade are a number of stick-lac markets which are really centres of collection and are generally situated on a railway. The routes by which lac finds its way to these markets are many and various and it often passes through many hands before it finally arrives there. In these lac markets, the dealers who supply the smaller manufacturers and the agents of larger manufacturers who find it advisable to make their own arrangements for supply of the raw product, meet by the agency of the usual broker.

The raw product lac or stick-lac reaches the manufacturers in a variety of conditions. Being collected and marketed in the first place by the most ignorant classes in the country, very little trouble is taken to market it in the form required by the manufacturer. It is frequently very dirty and mixed with a large quantity of stick; it is often adulterated with various rubbish, but

CSL

usually to no purpose, as the dealers are adept at estimating the real value of the article they buy; it is frequently not dried, in which case, if cut before the insects emerge, their dead bodies decompose and set up fermentation so that the whole filthy mass may coalesce into what is known as blocky lac. The better class cultivator strives to put his product in the market in a clean form and reaps his natural reward in better prices.

The object of manufacture is principally to refine the crude lac and remove insect remains and the dye they contain, fibre and vegetable matter, and other impurities. The usual country process is to break the lac off the stick and winnow it, after which it becomes known as *kacha chaori*. This is then washed repeatedly with water in a stone *nand* which removes the greater part of the dye, after which it is known as *chaori*. At this stage the blends are made, orpiment may be added to improve the colour and rosin to assist the later melting of low grade products. The blended lac is poured into a long sausage-shaped bag some thirty feet long by two inches in diameter. This is roasted section by section in front of a fire until the lac is melted. The section of the bag is then twisted up so that the lac is squeezed out. The workman scrapes the melted lac from the bag and passes it to an assistant, who flattens it out and as it cools, stretches it to a large thin sheet, which subsequently breaks up into small pieces in the form in which shellac is put on the market.

Several manufacturers employ improved methods, using solvents or steam to melt out the lac, but the details of methods are usually in the nature of trade secrets. These processes are more costly but give an increased yield; there is however a certain prejudice in the trade against machine-made shellacs.

There are various by-products of the trade, the principal of which are lac dye and *kiri*. Lac-dye, a rich carmine colour, was originally the main product of the industry, shellac being a by-product. It is now almost unsaleable, having been ousted by the aniline dyes, which are much cleaner and truer to standard. *Kiri* is a powder consisting of animal remains, vegetable matter

CSL

and a little lac, all in a finely divided state so that they cannot easily be separated. There is a ready market for *kiri*, which is largely used for the local manufacture of bangles. The principal manufacturing centres are Mirzapur, Calcutta, Jhalda and Balrampur (Manbhum), Pakaur (Sonthal Parganas), Imamganj (Gaya), Umaria (Rewah), Ranchi and Bundu (Ranchi). There are numerous smaller factories throughout the lac districts.

Shellac is always sold up to certain standards. The principal are TN and standard I, both non-proprietory marks and the latter being somewhat the better. Above these are the 'Fines' and 'Superfines' made by the better class manufacturers on proprietory trade marks. A smaller quantity of lac is marketed in the form of round, flat pieces known as button lac or solid lumps known as garnet lac.

The shellac export trade is almost entirely concentrated in Calcutta, which it reaches from the manufacturers through the usual agencies of dealers and brokers. The Calcutta TN daily quotation is the ruling price regulator throughout the trade, from the petty stick lac dealer (sometimes even the cultivator) to the Calcutta shipper. The trade from its nature is highly speculative, in the stick lac markets, in the manufacturing centres, in Calcutta and also in the foreign distributing centres. The cause is not far to seek and the root is found in the instability of the supply of the raw product. The cultivators are mostly agriculturists, and there is this difference between the cultivation of lac and agriculture, that the latter is a staple industry while the former merely provides the cultivator with subsidiary earnings to supplement those obtained from agriculture. A natural consequence is that the lac industry as a whole tends to be quickly affected by factors which would not affect a staple industry. When prices are low trees may be neglected and production falls off comparatively quickly; and when agricultural crops are good his natural indolence may lead the cultivator to neglect his lac. The margin of production in the case of lac is considerably wider and more elastic than is usual in the case of agricultural industries proper.

Almost all the shellac manufactured in India is exported. The principal importing countries are the United States of America and Great Britain, but many European countries and Japan take quite appreciable quantities. The principal uses for shellac are for gramophone records, spirit varnishes, hats, metal lacquer, brushes, emery wheels, and electrical appliances. As a varnish, it finds a use in a very large variety of trades. It is said that forty to fifty per cent. of all shellac is consumed by the gramophone industry and that no other single industry can account for more than five to eight per cent. consumption.

The total annual production of shellac is in the neighbourhood of 300,000 to 350,000 cwt. valued at some Rs. 7,00,00,000, so that its importance to India is obvious. There are distinct signs that interest in cultivation is awakening among the more educated classes whilst it has been taken up seriously on commercial lines in many of the Government forests, particularly in the Central Provinces and Bihar and Orissa.

6. BOSWELLIA SERRATA GUM-RESIN [1]

Boswellia serrata is a medium-sized tree, and found widely distributed throughout the dry zone forests. It is found from the Sutlej extending eastwards to Nepal, on the outer slopes of the Umballa and Saharanpur Siwaliks. It is common throughout Rajputana, Bihar and Orissa, in the Circars, the Central Provinces, Khandesh, especially on the slopes of the Satpuras, in the Deccan and Carnatic, but not found in Assam or Burma. The tree often forms the major part of the crop on hot, rocky hillsides, and is often the forerunner of better forests as soon as protection from fire and grazing is introduced. A good deal of information has been collected from certain localities as to the number of trees available for tapping, the figures in most instances being based on Working Plan valuations and reports from local officers. Though it will be seen from the following figures that the number of trees is very large, they only represent those in selected areas, about which information has been collected :—

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[1] Considerable information is given on this subject in the *Forest Records* (Vol. vi., Part vi.) by Pearson and Puran Singh, from which the above details are taken.

Bombay Presidency–Khandesh.	12 million trees.
Certain parts of the Central Provinces.	20 to 30 million trees.
Madras ...	Fairly abundant, but no details of available trees are known.

The above figures represent only a very rough estimate of the number of trees over ten inches in diameter, and the species occurs in many other localities as well as those mentioned.

The tree is practically useless for timber or fuel and its claim to fame lies in the fact that a gum resin exudes from the bark of cambium layer on tapping. A good deal of difficulty has been experienced in ascertaining the best method of tapping the tree, but after a long series of experiments spread all over India, the United Provinces, Central Provinces, Bombay and Gwalior, the following conclusions were arrived at as regards the method expected to give the best results :—

(*a*) The method of tapping should be by shaving off a thin band of bark some six inches broad, two feet to two feet six inches from the base of the tree.

(*b*) Tapping should generally be commenced in November and should stop before the break of the monsoon.

(*c*) Freshing should be undertaken every fourth or fifth day, and should consist in removing a thin shaving of half an inch to one inch of new bark from the upper edge of the original belt, and carrying down the freshing to within an inch of the lower edge.

(*d*) Tapping of trees below thirty inches in girth is not advocated.

(*e*) If, after the initial tapping and after the first freshing has taken place, individual trees yield little gum-oleo-resin, they should be excluded from the operations.

(*f*) The effect of tapping on the trees need cause no serious apprehension.

(*g*) Taking into consideration the number of trees available for tapping in certain localities, together with the yield per tree, the out-turn is sufficient to justify the erection of a plant working on commercial lines.

Pearson has made an estimate of annual out-turn taking into consideration the number of trees available for tapping, the yield per tree and other factors, and has shown that with an output of 2¼ lb. of gum-resin per tree per annum, the Khandesh divisions of the Bombay Presidency might be expected to produce over 100,000 maunds (say 4,000 tons) per annum; while the Central Provinces areas could possibly supply double this quantity.

The gum-resin of *Boswellia serrata* is very similar to the frankincense of commerce, and contains three main ingredients:—

Turpentine oil = 8 per cent.
Rosin = 55 ,,
Gum = 22 ,,

As the commercial demand for frankincense is extremely limited, the possibilities of separating the three ingredients were considered. This problem has been the subject of prolonged enquiry, and from the nature of the three products it is evident that the process of separation must be a mixed one, namely, solvent extraction to remove the gum, and steam distillation to remove the oil from the rosin. The process worked out on a semi-manufacturing scale at the Forest Research Institute, Dehra Dun, indicates the advisability of first distilling off the turpentine oil by superheated steam, and then dissolving the gum with petroleum benzine solvent, thus obtaining the rosin and finally evaporating the gum solution to recover the solvent and to obtain the gum.

Reports from commercial firms on the products obtained have been most promising. The turpentine oil has been shown as nearly equal to American and French turpentine oils for the manufacture of varnishes, etc.

The rosin is considered a satisfactory substitute for American grade rosin, and the gum is very similar to the ordinary gum-arabic of commerce. Also gum in which thirty to forty per cent. of rosin is allowed to remain unextracted has been tested as a sizing material in the manufacture of paper, but the results obtained were recorded as 'only fair.'

Pearson has made an estimate of the financial aspect of the business, based on *pre-war* prices of American turpentine and rosin (which seems unduly pessimistic), which gives a value of about £15 per ton of gum-oleo-resin for the manufactured products. If this figure is applied to the large potential yield of the gum-oleo-resin from Indian forests, the gross potential value of the industry becomes very considerable, and if markets and satisfactory working conditions are developed, the *Boswellia* gum-oleo-resin industry might in time produce £200,000 worth of products annually. A pioneer commercial firm has recently taken a lease of the *Boswellia* forests of parts of Khandesh, and has started operations on a manufacturing scale.

7. Cutch and Katha

One of the commonest and most widespread trees in India and Burma is *Acacia Catechu* (*khair*). It is found growing on dry rocky hills, on fresh river gravels and in the damp loam of the Tarai belt of forest. The heartwood is a deep rich brown, and contains two important products, i.e.—

Katha (*catechin*) which is found to the extent of four per cent by weight of the wood.

Cutch (*catechu*) composing 10 per cent. by weight of the wood.

Of these two products, *katha* is consumed almost entirely in the country and is not exported. Throughout India, one of the commonest customs amongst the Indians is the chewing of *pan*, which consists of betel, lime and *katha*, and with the saliva of the mouth forms a vivid red juice. A mouthful of *pan* contains only a few grains of *katha*, but so great and universal is its consumption that the total demand for *katha* is estimated to run into several

CSL

thousands of tons yearly. The market of Bombay, for example, will probably take 1,000 tons a year. The retail value of *katha* is about one rupee per pound, or nearly £150 per ton.

Cutch, on the other hand, is prepared chiefly for export to Europe. It is a preservative and khaki or brown dye, extensively used for fishing nets, for dyeing brown sails, mail canvas, and occasionally for textiles. The exports of *cutch* from India average about 30,000 cwt. valued at £70,000 annually and the export trade is chiefly from Burma.

The method of extraction employed for generations by the *cutch* and *katha* workers in the forest is crude and wasteful in the extreme. A tree is felled, and the heartwood chipped up by hand with an axe. The chips are collected and boiled up in a pot, thus bringing into solution both the *cutch* and *katha*. While both substances are soluble in hot water, only the former is soluble in cold water; thus when the decoction cools down, the latter deposits as a powder. The mixture is filtered through sand, a large proportion of the *cutch* is lost, and from ten to fifteen per cent. of sand and impurities become mixed with the *katha*.

During the last few years, a company has been floated in the United Provinces, which by using a vastly improved patented method of manufacture, with steam-stills, vacuum pans, etc., obtains the maximum quantity of both ingredients in a very pure state. This is but one example of the tendency in modern India to-day to replace the crude and primitive methods of quasi-cottage industries by modern and more scientific manufacturing methods and machinery. There is nearly always a strong demand for all available supplies of *khair* trees, and the future developments of this industry appear to depend rather on improved manufacturing methods than on increased supplies of trees.

8. Drugs and Medicinal Herbs

Indian forests are rich in herbs, shrubs, and fruits which have an actual or potential value for medicinal purposes, and there is little doubt that in course of time further chemical and botanical research will steadily add to the number of valuable products. A few of the better-known will be briefly indicated here, as examples.

(1) *Strychnos Nux-vomica.*—A medium-sized tree which is found growing naturally in the forests of Bengal, Orissa, the Deccan and Carnatic, of Bombay and Madras, especially along the fringe of the evergreen forests, and the deciduous forests all over Burma. The importance of the tree lies in the fact that the seed contains strychnine. A typical sample of seed will contain about 1·4 per cent. strychnine and 1·6 per cent. of brucine, or 3 per cent. of total alkaloids. The tree bears a plum-like fruit that produces the seed, which is round and flat, much resembling a satin-covered dress button, silvery and light bronze in colour, and varying in size from one-third to one inch in diameter. The seeds are harvested from March to July, the best qualities being obtained from the trees before the seeds fall. The jungle gatherers sell their produce to village *banias* from whom the product is bought by merchants and taken to the exporting markets. From 40,000 to 50,000 cwt. of seeds are exported annually from India, chiefly to the United States of America and Europe, the approximate value being £15,000 to £25,000.

(2) *Podophyllum emodi.*—This is a common under-shrub in the Himalayan forests, occurring generally at between 6,000 and 9,000 ft. altitudes in the drier western zones, especially in Kashmir. It is a herbaceous plant rarely attaining a greater height than one foot. The root system is perennial and consists of a rhizome with numerous thin rootlets branching from it. The active and valuable principle is found only in the root system, and consists of a resin which contains *podophyllotoxin*, and numerous analyses of the dried roots have proved that they contain from 10 to 20 per cent. by weight of resin, and the resin from 25 to 50 per cent. of the active toxin. This shows that the rhizome of *podophyllum emodi* is twice as active as that of the American *podophyllum peltatum*. *Podophyllum emodi* was included in the British Pharmacopoeia in 1914, and is thus officially recognized

for use. No reliable information is available to show what quantity of roots or resin is exploited annually in India.

(3) *Taraktogenos Kurzii* (*chulmugra* oil).—A medium-sized tree which is found in the forests of Assam and Burma in areas of heavy rainfall. The seeds of the closely allied *Hydnocarpus Wightiana* found on the West Coast yield an oil which is chemically identical with that of the above species. From the seed of this tree an oil is expressed, which has valuable medicinal properties, and has been used for countless years by the local inhabitants for skin diseases and rheumatism, while Sir Leonard Rogers, F.R.S., I.M.S., discovered its use for leprosy. About 30 per cent. oil is obtained by crushing selected and good quality seed. The annual output of seed varies enormously; in some years the seed crop entirely fails and there is none available for export, in other years much of the seed goes to waste in the forest. In pre-war years from 3,000 to 5,000 cwt. was the average quantity of seed brought into the Calcutta market.

(4) *Artemesia maritima.*—The drug santonin occurs in the young flower-heads of *Artemesia maritima* and finds an extensive use in medicine as a vermifuge. Prior to the war practically the whole of the world's supply came from Russian Turkestan, where the flower-heads were gathered and the drug extracted. It has not been possible to obtain any recent data as to the size of the industry, but the area under *Artemesia maritima* must have been considerable, since in 1885 one factory dealt with 1,600 tons of the flower-heads. At that date there were apparently at least two other factories, but no information is available as to their output. The industry was conducted in a somewhat primitive fashion; the plants were pulled by the nomad inhabitants of the district, who stripped off the flower-heads and used the remainder of the plant as fuel.

At this time the value of santonin was estimated at £2 to £3 per kilo., but it could apparently be sold in Hamburg with a profit at 18*s.* a kilo. As a result of the unsettled conditions prevailing in Russian

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Turkestan no santonin is now being placed on the market and the present price stands at the amazing figure of £50 per kilo. It is obvious, therefore, that some other source of supply of this valuable drug must be sought if adequate supplies are to be available once more.

It has long been known that *Artemesia maritima* occurs in Kashmir and Garhwal, but no systematic survey has been made of the quantity available, nor have experiments been made to determine whether the plant growing in these districts contains santonin, for it is well known that difference in habitat frequently alters the chemical constituents of a plant.

In 1919 Mr. Coventry, Conservator of Forests, Kashmir, sent several specimens of the leaves of *Artemesia maritima*, which had been collected in Kashmir, to the Forest Research Institute, Dehra Dun, with the request that they might be tested for their santonin content. As a result of systematic examination it was found that *Artemesia maritima* grown in Kashmir contained an appreciable quantity of santonin, and an average of about 1 per cent. by weight of dry leaves was found to be the santonin content. This percentage, whilst lower than that quoted for Russian *flower-heads* (which is said to be about 2 per cent.), is still considerable. Mr. Simonsen, the Forest Chemist at Dehra Dun, who carried out the analysis, in an article in the *Journal of Indian Industries* wrote that '*Artemesia maritima* grown in Kashmir contains santonin in sufficient quantity for remunerative extraction, and from the information available there would appear to be sufficient supplies of the raw material. It now only remains for the laboratory results to be utilized on the large scale. The method of extraction is comparatively simple, and the only chemicals required are lime, hydrochloric acid and alcohol, all of which are readily obtainable in India. As the leaves are bulky, the factory should, if possible, be situated in Kashmir.' Collection of the raw material has been started on a large scale, and the present is a favourable time for starting the new industry, since at present there is no competition to meet.

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9. The Bassia Tree and Its Products

One of the trees of principal economic importance in India, but which seldom receives more than a cursory note in Forest administration reports, is *Bassia latifolia* (known by the vernacular names of *mowra*, *mahua*, *mahura*, *mohwa*, etc.). It is indigenous and very widespread in Central India. In South India and Ceylon its place is taken by *B. longifolia* which is put to the same economic uses. The third tree is *B. butyracea* of the Sub-Himalayan tract, known as the Indian butter-tree.

The seed of these trees yields an important commercial product in the form of the valuable edible fat known as Illipe butter, largely employed by the native as a foodstuff. Before the war the export of seed to Europe was considerable, being mainly utilized in Germany and Belgium for the manufacture of margarine, soap, candles, etc. The Imperial Institute has published numerous articles on the economic uses of these species from which the following notes are taken. Amongst the native population of India the chief importance of the *mowra* tree lies in the flowers, which are rich in sugar and highly valued as a foodstuff and as the source of a spirituous liquor. Some conception of the value put upon the flowers for these purposes by the natives is gained from the estimate made thirty-three years ago, that in the Central Provinces over 1,000,000 people used the corollas of the *mowra* as a regular article of food, each person consuming about 80 lbs. per annum. In the Bombay Presidency they are also used for domestic consumption on a large scale and throughout India are looked upon as a valuable reserve in famine years. The flowers of *B. butyracea* are not eaten, but a syrup prepared from them is boiled down yielding a sugar about equal in quality to date sugar.

The *mowra* tree sheds its leaves in February and the flowers appear in March and April, at which time the ground beneath the trees is carefully cleared.

The flowers have a thick, juicy, globe-shaped corolla of a pale cream colour, enclosed at the base in a velvety chocolate-coloured calyx. The corollas fall in the early hours of the morning and are collected by the women and children. They are spread out to dry on mats in the sun, when they wither to half their weight and develop a brownish-red colour. In some cases the flowers are collected before they drop, and in many places it is the practice to remove only the corollas, leaving the pistil to ripen to a fruit. A tree will yield 200 to 300 lb. of flowers in a year.

When fresh the flowers are extremely sweet with a peculiar pungent flavour and a characteristic odour. When dry the peculiar pungent odour is less perceptible, particularly if the stamens are removed, when the flavour resembles that of figs. The flowers are eaten either fresh or dried, and cooked in many different ways, with sal seeds, rice, shredded cocoanut, or flour.

The greater portion of the crop of flowers is used for the preparation by fermentation of *daru* or *mohwa* spirit. For this purpose jars holding from 10 to 20 gallons are charged with 10 to 20 seers of dried flowers, spent wash and water. In some cases molasses is added and may replace as much as half the quantity of the flowers. The mixture is left to ferment, which requires from three to seven days according to temperature, and the liquor is then distilled from crude earthen pots. The distillate so produced ranges from 50° to 90° under proof. A second distillation is sometimes made raising the strength to 25° under proof. Native spirit prepared in the way described has an offensive butyraceous odour and is rich in fusel oil, one sample examined by Elsworthy containing 3 per cent. of fusel oil (*Journ. Soc. Chem. Indust.* 1887, 6, 23) On rectification this unpleasant odour is largely removed. By the native method one maund (82 lb.) of dried flowers yields about 2·12 gallons of proof spirit, but in England it was found that over 6 gallons of proof spirit could be obtained from one cwt. of the flowers. It has been found that *mowra* flowers which have been kept for some months yield a better spirit than when quite fresh, but if over twelve months old they are not so well suited for distillation.

About 1888 there was a considerable export of the flowers to Marseilles for use in making a cheap brandy; but the French Government, in order to protect the home grape industry, prohibited the import.

The composition of the flowers has been investigated at different times, and the results vary considerably, particularly in respect of the quantity and nature of the sugar present. The total amount of sugar recorded in the flowers of *B. latifolia* varies from 40 to 70 per cent. The quantity of cane sugar recorded varies from 3 to 17 per cent., and that of invert sugar from 40 to 53 per cent., whilst one author has stated that the sugar is entirely invert sugar. The dried flowers of *B. longifolia* have been stated to contain about 70 per cent. of sugar. Only a small quantity of protein is present, the maximum amount recorded in either species being 7·25 per cent.

Thirty years ago attention was directed to the richness of *Bassia* flowers in sugar and the possibility of their being used in India as a source of sugar for export; but when it was established that except for a very slight proportion the sugar was uncrystallizable and therefore of little value except perhaps as a brewing sugar, the interest from this point of view died down. To-day with an enormous European production of beet sugar to compete with, the probability of *Bassia* flowers being called upon to supply any part of the world's sugar requirements is more remote than ever.

During the war interest was centred in the production of acetone from *Bassia* flowers in India to supply the local demand in connection with the manufacture of munitions. The acetone was produced by the now well-known special fermentation process, and it has been alleged that the yield from the flowers of *Bassia latifolia* was one-tenth of their weight, or nearly ten times as much as is obtainable by distilling wood. The demand for acetone in India in peace times would not be large enough to justify the available supplies of flowers being entirely devoted to the manufacture of that product, but there remains the possibility of their being used for the manufacture of industrial alcohol. Derived from a forest tree, the other products of which are also of a considerable economic value, they appear to represent an exceptionally cheap source. The yield of alcohol from the flowers is high compared with that from potatoes and other materials commonly used. It has been stated that about 90 gallons of 95 per cent. alcohol is obtainable from one ton of dried flowers.

In view of the extended use that is now being made of alcohol for power purposes it seems likely that the most profitable way of utilizing the flowers would be as a source of a mixed motor spirit of the 'natalite' type for local use in India. That motor spirit can be produced on a manufacturing scale in India from *Bassia* flowers has already been demonstrated, and it is stated that running trials with the spirit proved satisfactory.

'Natalite' is mainly a mixture of alcohol and ether and its manufacture involves not only the production of alcohol from the flowers but of ether from the alcohol. It would be necessary to set up an extensive plant for this purpose and whether such a procedure would be profitable depends largely on the cost of collecting the raw material, which in turn is dependent to a great extent on the quantity available.

According to information supplied to the Inter-Departmental Committee on Alcohol Motor-Fuel by the Director of Commerce and Industries to H. E. H. the Nizam of Hyderabad, the total cost of collecting and drying the flowers and delivering them to a factory in the zone of growth amounts to £1 10*s*. per ton. This estimate, however, refers only to Hyderabad, where the conditions are particularly favourable owing to large numbers of the tree occurring together. In regions where the trees are more scattered the cost delivered to a factory would naturally be higher, and in such cases it would probably not pay to utilize the flowers on a commercial scale, unless the tree was cultivated for the purpose.

It has been estimated that in the Hyderabad State alone there are already sufficient *Bassia* trees for the production of 700,000 gallons of proof spirit per annum, in addition to that necessary for the local liquor requirements.

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It is impossible to estimate the annual value of the flower crop, or to ascertain the quantity and value of the timber and fuel utilized annually throughout India. The figures of export of seed in pre-war times are given in the following table :—

	1910–11		1911–12		1912–13	
	Quantity	Value	Quantity	Value	Quantity	Value
	cwt.	£	cwt.	£	cwt.	£
British Empire	32,325	15,741	6,060	3,046	...	...
Foreign Countries	383,337	191,616	789,066	389,304	265,858	142,911
Total ...	415,662	207,357	795,126	392,350	265,858	142,911

	1913–14		1914–15	
	Quantity	Value	Quantity	Value
	cwt.	£	cwt.	£
British Empire ...	...	...	106,248	32,087
Foreign Countries ...	665,954	363,617	42,494	18,587
Total ...	665,954	363,617	148,742	50,674

The mohwa seed exports subsequent to the war are as follows :—

	1919–20		1920–21		1921–22	
	Quantity	Value	Quantity	Value	Quantity	Value
	cwt.	£	cwt.	£	cwt.	£
	44,200	32,200	101,220	56,255	18,200	10,300

Apart from the importance of the flowers and fruit, the *mowra* tree gives a useful dark red timber and excellent fuel. There are in fact very few species in or out of India which give such a variety of useful and valuable products. It appears however to be decreasing in some districts. This is due partly to the fact that the dead leaves and grass under the trees are cleared away and burnt, in order to facilitate the collection of the flowers, with the result that natural regeneration is hindered. It is important therefore that attempts should be made to encourage the cultivation of the tree, for in addition to the question of the production of alcohol from the flowers, and the value of the seed as a source of oil, the flowers form a valuable food for the natives, particularly in famine years. The tree is well adapted to withstand drought, and is specially suited for planting on dry and waste lands, where little else will grow.

10. OIL SEEDS

A larger number of trees and shrubs other than those mentioned above produce seeds containing fatty oils, used for a variety of purposes. Thus *Garcinia indica* oil from the seed is used for food and medicine, the seeds of *Mimusops Elengi* give an oil used in cooking and lighting, while walnut oil is produced from the kernel of *Juglans regia*. Many other instances could be mentioned, but it is only possible to mention a few in detail.

Kusum oil is obtained from the seed of *Schleichera trijuga* and is a dark yellow oil, much in use as a hair dressing, in fact it is said to be the basis of Rowland's Macassar Oil. A detailed enquiry was carried out with this oil for soap-making, a large consignment being sent to a soap factory, who passed it as entirely suitable for the purpose. Kernels of best quality yield as much as 56 per cent. of oil, and the average may be taken at 40 per cent. The tree grows in deciduous forests in the greater part of India and Burma, and is common in the Central Provinces and Deccan. There is a very fair prospect that if collection were properly organized this seed would be a commercial proposition.

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Piney tallow is obtained from the seed of *Vateria indica*, a very common species in the West Coast forests, Coorg and Mysore. The yield of oil is said to be from 30 per cent. to 50 per cent. and is largely used as a vegetable butter. During the war a considerable quantity of this 'butter' was exported to Europe for food purposes, and it is still used by the local inhabitants. *Sal* butter from the cotyledons of the seed of *Shorea robusta* is obtained by boiling the seed in water and skimming off the oil which collects on the top of the water. It is a solid white mass when cold, used for cooking in most places where *sal* is found. Since the introduction of forest protection this foodstuff has gone out of use, owing to the value of the seed for reproduction.

11. CANES

The trade in canes in India is very much larger than is generally supposed, and the Forest Department in several provinces derives considerable revenue from this source. The most valuable species are *Calamus tenuis*, *Calamus viminalis*, *Calamus latifolius*, *Decomorops Jenkensianus* and *Calamus gurba*. The most important centres of trade are the Lakhimpur and Cachar divisions of Assam, the Puri division of Bihar and Orissa, the Ruby Mines, Thaungyin, Rangoon and northern divisions of Burma and parts of the West Coast. To give a rough idea of the amounts annually extracted it may be stated that as many as 14,700,000 running feet has been extracted from Cachar in one year, while the total quantity extracted from Assam per annum is about 30 million running feet. Burma also extracts very large quantities of canes, which together with those in India are largely used locally. The export trade is not large, but might be developed. In 1920-21 the value of the exports was Rs. 55,890.

12. FIBRES

A very large number of fibres are obtained from the leaves, bast and seed of forest trees and from grasses. The most important leaf fibres are obtained from species of *Agave*, while those of the talipot palm (*Corypha umbraculifera*) and *Licalda peltata* are of great economic importance on the West Coast and the latter in Bengal, Assam, Burma and the Andamans.

Many trees yield fibres from the bast or bark, *Sterculia villosa* being the most important, especially in Burma, where all elephant drag-ropes are made of the fibre. The fibre of *Helicteres Isora*, a small shrub, extensively found in many of the dry forests, is made into rope and has been passed as very suitable by a large rope factory in India. Silky fibres are obtained from the giant nettle (*Girardinia heterophylla*) and from *Calotropis gigantea* and *C. procera*, which are used for fishing lines and nets. A similar fibre is obtained from *Urena lobata*, a weed in the forests, while cordage is also made of the fibres of *Kydia calycina*, *Sterculia* spp., *Bauhinia Vahlii*, an enormous creeper, *Trema* spp., and many others.

Certain seeds produce flosses, or kapoks, the most important of which is the floss of *Bombax malabaricum* of which thousands of maunds are collected annually and used for stuffing pillows and mattresses. The seed of *Cochlospermum Gossypium*, *Eriodendron antractuosum* and *Calotropis gigantea* are other examples of floss-yielding shrubs or trees.

They are several important grasses found in the forest, other than those used for thatching and yielding essential oils. *Baib* or *sabai* grass (*Ischaemum angustifolium*) is the best raw material in India for paper-making and is also used for mat-making and rough cordage. *Munj* (*Saccharum arundinaceum*) is of nearly equal importance as it supplies the major portion of the raw material for mat-making, basket and chair-making in Northern India. *Typha elephenta* is also used for basket and mat-making, but is not of equal importance to *munj*. The thatching grasses are *Imperata arundinacea*, *Saccharum narenga*, *Saccharum spontaneum*, and others of less value.

CHAPTER VI

FUTURE POSSIBILITIES

THIS review of India's forest wealth would be incomplete without some note on the future possibilities of development.

The possibilities of developing and increasing the value of India's great forest estate may be divided into the following main sections :—

(1) Improvements in the growing stock.
(2) Concentrated methods of working and management.
(3) Development of new uses, markets, and demands.
(4) Improved methods of extraction and exploitation.
(5) Greater attention to minor forest products.

At the outset, the following rather remarkable figures must be considered.

It has been calculated that the forests of British India (i.e., excluding the extensive areas of Indian States) produce annually about 1,200 million c. ft. of timber, that of this only about 340 million c. ft. (or one-third) is utilized, that despite this available balance, imports of timber into India exceed exports by 5½ million c. ft., and finally that the Indian consumption per annum per head of population is the extremely low figure of 1½ c. ft., or about one-eighth of the corresponding consumption in such countries as Great Britain, South Africa, or Australia. It is at first sight rather incomprehensible that a country which does not consume or utilize more than one-third of its own home-grown timber, should yet import considerably more timber than it exports, and in addition import enormous quantities of products made from wood (matches, tool-handles, bobbins, tea-boxes, wood-pulp, etc). The explanation is dependent on a number of different factors, among which may be mentioned the following :—

i. Vast forest areas are still quite inaccessible and, under existing conditions, unworkable. The unclassed forests of Burma and Assam (and many forests in other provinces also) come into this category. Their annual timber production is therefore economically negligible, until they are made accessible.

ii. In the mixed forests of India (pure forests of one or two species are quite the exception) frequently only two or three species are of any commercial value, and the remainder at present economically useless. Out of 2,500 species of trees which occur in India, scarcely 20 per cent. are of economic value, and the annual timber production of the remaining 80 per cent. must therefore be ignored. One of the main objects of economic forest research in India at the present time is to find new uses for these so-called 'jungle-woods,' which, as described later, is a branch of work of immense potential value, and every year new uses for jungle timbers are being discovered.

It is easy however to realize that although the total annual wood production in the forests of British India is 1,200 million c. ft., yet the effect of these two factors is to whittle down the annual production of *utilizable* timber to a very much smaller figure. Again, with the gradual industrial, economic and social development of the country it seems impossible that the timber consumption per annum per head of population should permanently remain at its present low figure of 1½ c. ft., and a comparatively small rise would tend to wipe out any surplus of annual utilizable timber production over annual consumption. It is in fact unlikely that India will ever show a surplus of timber exports over imports; indeed, with a growing population already exceeding 250 millions within her borders, such a contingency can scarcely be expected and would in fact be sign of poor industrial development. But that a great eal can be done (and is being done gradually as limited unds and staff permit) to increase the value of India's

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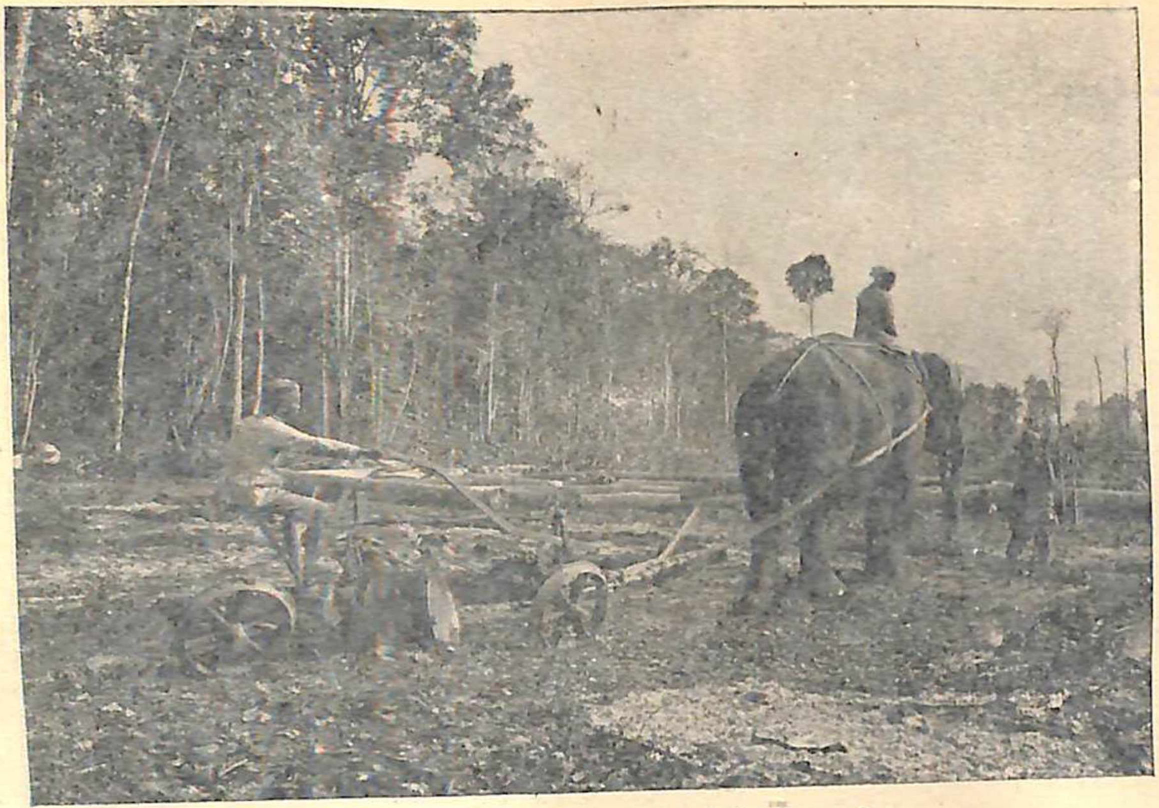
forests, the descriptions given in the following paragraphs will show.

(1) IMPROVEMENTS IN THE GROWING STOCK

For the past fifty years (i.e., since the creation of the Forest Department) the hand of the forester has been hard at work, steadily increasing the productivity and value of forest lands. It has been the fundamental basis of all forest management in India never to fell a tree unless young growth is already present or can be guaranteed to replace it; the principle of 'sustained yield' has been consistently followed. The heavily overworked and semi-ruined forests of fifty years ago have, with care, protection, and the wonderful recuperative power of many Indian species, been converted into flourishing and vigorous crops, and annual tendings, cleanings, thinnings, climber cutting, etc., still continue the good work. As a concrete example, the yield capacity of the valuable *sal* forests of the U. P. and Bengal have increased five to ten-fold in the last fifty years, and there must inevitably be a further considerable increase in the next fifty years.

Again, the steady replacement of less valuable by more valuable species, both in the natural forests and by plantations, is an important cumulative factor in increasing the value of forests. The girdling or killing of less valuable species to give light and growing space to young poles and saplings of the more important species such as teak, *sal*, deodar, etc., is carried out annually over extensive areas in all the more important forests of India, while the teak plantations of Nilambur and Burma, the *taungya sal* plantations of Bengal, and the deodar plantations of the Himalayas are typical examples of a more concentrated form of the same action, and the well-known blue gum plantations of the Nilgiris, the irrigated plantations of the Punjab, the ravine plantations on the banks of the Jumna, and the *Casuarina* plantations of the sea-shores illustrate the conversion of barren an useless waste lands into productive forests.

Unquestionably the improvement in the growing stoc



Intensive forest management in Bengal.
Clear-felling followed by ploughing and sowing.

which has steadily gone on for the last fifty years and is going on with accelerated force at the present time, is the predominant and most hopeful factor when considering India's forest wealth in the future. It is for this reason that research in silviculture (which determines the best ways of creating and growing forest crops) is regarded as of supreme importance throughout India to-day.

(2) CONCENTRATED METHODS OF WORKING AND MANAGEMENT

Throughout India to-day there is a marked tendency in all Working Plans to introduce more concentrated and more intensive forms of management. The foresters of the last generation who had to prepare the Working Plans were frequently faced with the problem of the mixed forests, in which out of perhaps a hundred species growing together only two or three were saleable or commercially exploitable. The annual fellings were limited by a fixed number of trees of the saleable species, and the forester, marking his forests for felling, took a tree here and a tree there, so that the fellings were necessarily extremely diffuse, and any form of logging or mechanical extraction of the timber was impossible. Troup was the chief protagonist for introducing improved methods of working which would ultimately lead to a more concentrated yield, and in all the principal forests of India more concentrated systems of management are being introduced as far as possible. Typical examples are the mixed forests of Burma, the Andamans and the Western Ghauts, the *sal* forests of Bengal and the United Provinces, the Himalayan coniferous forests, etc. It is evident that a square mile of forest, well stocked with trees *all* of which are saleable, and which have grown up properly tended under intensive management, is of far greater value than twenty square miles of partially stocked forest and of largely unsaleable trees of the usual type. The introduction of intensive silviculture is also being continually simplified by the growing demand for jungle-woods, new uses for which (as explained in the next section) have been and are being found by the unremitting work of the utilization specialists at Dehra Dun and in the provinces, and of the Government timber agents and others. Thus research in utilization simplifies the introduction of improved silviculture, which in time will on its part greatly simplify the utilization of the forest crop, and the two together will add enormously to the value of India's forests.

(3) Development of new Uses, Markets and Demands

The complete development of the timber resources of India cannot be accomplished until uses are found for the majority of those timbers, the supply of which at present exceeds the demand or for which there is no demand at all. The reason why so many Indian timbers are not on the market is either that they are not durable or are liable to split and warp, or that their strength has not been determined, or that the correct method of conversion has not been worked out. Then again, many Indian timbers, not now on the market, but of great value, have been completely overshadowed by such timbers as teak, *sal*, deodar, blackwood, *pyinkado*, etc., which stand out as of pre-eminent value even when classed amongst the best timbers of the world.

Of all the factors that tend to retard the development of those timbers which are now not in use, the chief are the want of correct methods of seasoning and data as to the mechanical strength of such timbers. One may go far through India and never find a single stack of correctly piled timber, or find such a stack properly protected from the sun and hot winds, and yet there are few countries in the world where greater necessity exists for such care. On the other hand air-seasoning experiments, started some six years ago and greatly extended about three years ago, prove that such species as *Schima Wallichii*, *Terminalia paniculata*, *Albizzia stipulata*, *Alstonia scholaris*, *Boswellia serrata*, *Eugenia Jambolana*, *Garuga pinnata*, *Hardwickia pinnata*, etc., all of which are very liable to split and warp and which for that reason cannot be sold, can by correct methods of seasoning and stacking be rendered perfectly serviceable for general purposes. A full[1] report on these experiments has been prepared by Mr. Sweet, the officer in charge of the seasoning section of the Forest Research Institute. To use timbers for high quality work, such as panelling, furniture-making, bobbin manufacture, gun-carriages, rifle stocks and such purposes, it is necessary to season the wood completely, and to do so the timber should be kiln-dried. In the past much timber has been imported for such purposes, which could well have been supplied by India, but owing to want of knowledge in kiln-drying and want of kilns it has not been possible for indigenous woods to compete with the imported timbers. A start has however been made, as the Forest Research Institute have erected seven drying-kilns of two different types, with which it is hoped many of the intricate seasoning problems may be solved. The wood-working industry at Bareilly also have put in two steam spray kilns and have carried out experiments with twelve species of timber and determined standard methods of kiln-seasoning for seven species. As a concrete case of the value of kiln-seasoning may be cited army rifle stocks, which up to a few years ago were all imported. Now, owing entirely to the introduction of seasoning-kilns in the vicinity of the forests, the timber is entirely supplied by India. There can be little doubt that by introducing correct methods of seasoning, whether air or artificial methods, according to the purpose for which the timber is required, more will be done to promote the use of the so-called 'useless timbers' than in any other way.

It has been mentioned above that want of concise data as to the strength values of nearly all Indian timbers adversely affected their general introduction on the market. It is true that a considerable amount of information has from time to time been collected on the subject, but owing to certain factors having been ignored, and to the want of timber-testing machines, the available information is not to be relied upon. The Great War brought this point out most clearly, and, soon after peace was declared, steps were taken to remedy this last defect. For the last three years systematic timber-testing has been carried out at the Forest Research Institute, with three universal timber-testing machines and one Hatt-Turner Impact machine, with the result that some 12,000 tests have been completed. As 500 tests are required on each species, progress is relatively slow, and to speed up the work three more machines are being erected and two more are on order. As an example of the value of such work an instance may be mentioned which relates to oil sucker rods. At present hickory is imported for the purpose to the value of about seven lakhs of rupees annually. By carrying out tensile and shearing tests it has been proved that *sundri* (*Heritiera minor*) and, with a slight alteration in the iron connecting piece, *sain* (*Terminalia tomentosa*), do equally well for the purpose. Then again, by carrying out dog-spike pulling tests and tests for hardness, spruce and silver fir have been proved mechanically strong enough for railway sleepers, which fact at once enormously increases the available supply of sleeper woods, and at the same time opens up a fine market for two otherwise almost unsaleable timbers.

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[1] *Indian Forest Records*, Vol. IX, Part V, of 1923.

The reference to the two last named woods brings us to the question of durability of timber. It is well known that many strong and otherwise desirable timbers are not durable, that is, they are liable to fungus and insect attack. It is equally well known that seasoning the timber greatly increases its durability. But this is not sufficient in itself. As long ago as 1909 experiments were started at the Forest Research Institute, in conjunction with the Railway Board, with the object of testing the durability of certain timbers after treatment for railway sleepers. The reason for doing so was twofold, one being to find new uses for non-durable hardwoods and the second to endeavour to check the import of foreign sleepers, which by the adoption of proper methods of treatment could be replaced by Indian timbers. To illustrate the scope there is in such a market, it may be

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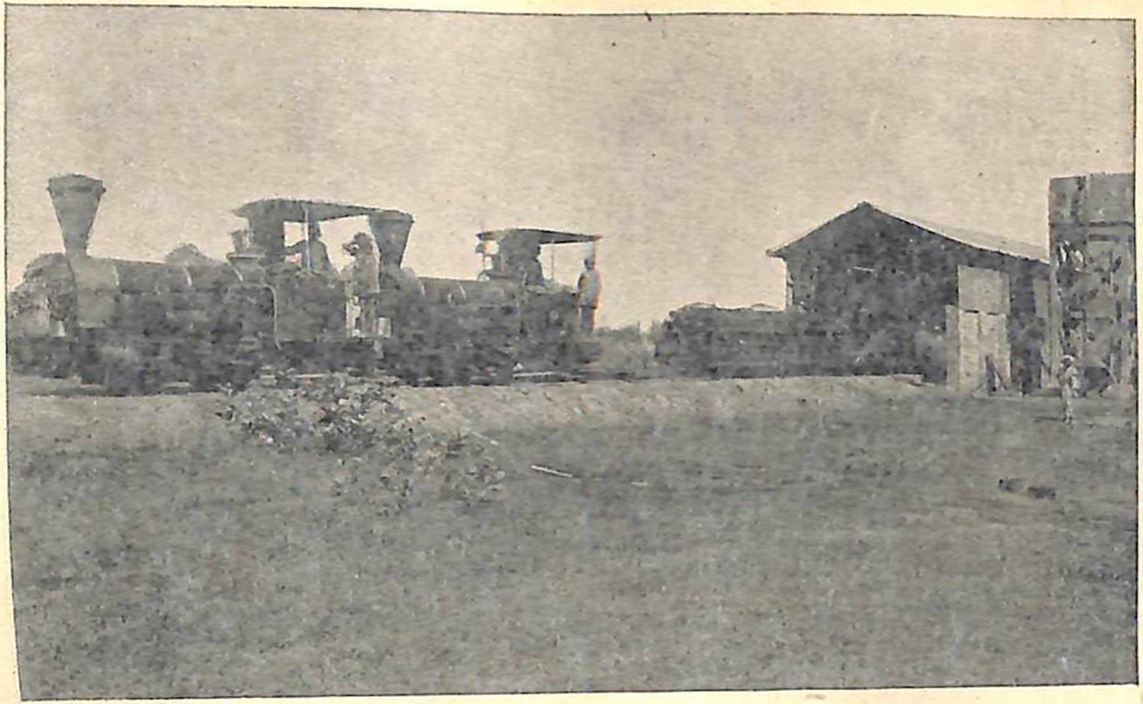
Plate XII.



North Western Railway creosoting plant, Punjab.

stated that India requires approximately 6 million sleepers of all sizes per annum, which may be valued at about 30 to 35 million rupees. The purchases for 1922 were in the neighbourhood of 4½ million sleepers, of which some 400,000 were imported. That the balance required was not obtained was due to want of indigenous sleepers and to financial stringency. Now the experiments above referred to have proved conclusively that a well-treated sleeper of an otherwise perishable wood is a sound proposition, and the railway authorities have accepted it as such, with the result that two pressure creosoting plants have been erected, and other similar schemes are under consideration. The industry is in its infancy, but a good start has been made, for which, owing to the many suitable timbers available for treatment, there is a great future. The results of these experiments are given in the reports mentioned in the foot-note.[1]

A line of research which has resulted in finding new uses for Indian timbers is the manufacture of tool and pick handles, of jute and cotton bobbins, of cotton reels, plane trees, rollers and similar turnery articles, as many Indian timbers are sufficiently strong and elastic for the purpose of handles, while others turn to a clean, smooth surface. It might be supposed that for such small articles as bobbins no great quantity of timber is necessary, but a large bobbin factory in England requires some 50,000 tons of timber annually to keep it running, while the annual amount of imported bobbins into India for the last three years was valued at Rs. 73,51,948. The same may be said of tool and pick handles, as one Indian railway alone requires over 12,000 tool handles and the total demand in India is over 200,000.

A great deal of extremely valuable pioneer work has been done by the Wood Working Industry at Bareilly in testing timbers for tool handles, and it has been determined that *bakli* or *dhaura* (*Anogeissus latifolia*) is an admirable timber for the purpose. The timbers of

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[1] *Indian Forest Records*, Vol. IX, Part 1 of 1922 and in Technical Note No. 231 of the Railway Board.

kau (*Olea ferruginea*), *dhaman* (*Grewia tiliaefolia*), *temru* (*Diospyros Melanoxylon*), *babul* (*Acacia arabica*), *tiwas* (*Ougeinia dalbergioides*), *sundri* (*Heritiera Fomes*) and many others are equally suitable.

A branch of the same institute at Clutterbuckganj has proved on a commercial scale that cotton bobbins of various types and of excellent quality can be made of *haldu* (*Adina cordifolia*), and of a somewhat lower grade of *papri* or *kanju* (*Holoptelea integrifolia*). Other timbers have been tested, which give fair results but not equal to *haldu*. Jute bobbins can also be made of the above species, and are an equally attractive proposition.

The demand for better class furniture is increasing as time goes on and as education spreads in India, and as probably no country in the world possesses such a variety of ornamental woods, this industry presents many possibilities for introducing new species into the market. The basic principle when dealing with ornamental woods is to convert the timber in such a way that the 'figure' is brought out to its best advantage. This is a line of enquiry that has been much neglected in the past when attempting to find new uses for timber. Concrete examples may be mentioned of woods which are now considered practically valueless but which if properly converted present a beautiful appearance as panels. *Dillenia pentagyna* of the West Coast, if carefully quartered, has a very ornamental wavy grain, known as 'fiddle-back mottling.' Then again, *farash* (*Tamarix articulata*) quartered has a very pretty silver grain. A very striking example is that of *Cordia Myxa*, a small tree of the Central Provinces, which is classed as firewood, but which, if cut on a tangential section, makes up into a beautiful panel. Many other similar examples could be cited but enough has been said to demonstrate the enormous field for expansion in this class of work.

Mention has been made above of quartering or cutting timber on a tangential section so as to show the different characteristics of timber to the best advantage, but it remains to discuss the question of cutting logs on rotary machines and the effect of doing so. Cutting timber on a lathe produces a thin board of timber, which

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may be anything from $\frac{1}{120}$ inch to $\frac{3}{8}$ inch in thickness. Such sheets when stuck together with a grain of each piece at right angles to the next produce three-ply, five-ply or seven-ply as desired. Such made-up boards are extremely strong and at the same time when cut from many species present an extremely ornamental appearance, due to the oblique section cut through the successive annual rings and the corresponding wavy appearance on the surface of the timber. Besides the question of minimum loss in material by this process of conversion, the made-up board is of great value for use in the trying climate of India, owing to its not expanding and contracting under varying conditions of temperature and humidity. This is explained by the fact that wood only expands and contracts across the grain and, as the board is made up of sheets with the grain at right angles, the tendency of one board to move is checked by the adjoining section. The veneer industry is still in its infancy in India, and several difficulties have still to be overcome, but it nevertheless has great possibilities, as not only are eminently suitable timbers available but the demand for such articles is greatly on the increase, especially for the ornamental class of ply wood.

An illustration of the difficulty caused by these two factors in India is afforded by the match industry. The import of matches into India at the present time is about 14,000,000 gross boxes per annum valued at well over two crores of rupees. These are large figures and the question naturally arises as to whether India cannot manufacture matches in sufficient quantities to supply the greater part of her requirements in this direction.

The import duty on foreign matches is now Rs. 1-8-0 per gross and at first sight it would appear that India has been very remiss in allowing such a promising industry to pass unnoticed. There is, however, another side to this picture and that side is unfortunately rather a black one. In the first place matches cannot be made without a suitable timber to make them from and despite India's wealth in timber trees of every description there is a very distinct dearth of timbers which are suitable for making good quality match splints. During the last

CSL

twenty years or so several attempts have been made to overcome this difficulty but almost without exception disaster has overtaken each enterprise and the difficulties encountered proved too great for the struggling pioneers. In some cases bad management was the cause of collapse, in others want of capital or technical knowledge, but in the majority of cases it was the lack of suitable timber which proved fatal.

These costly experiences have not, however, proved valueless. They have taught India many lessons and have shown up the pitfalls to be encountered. These are now common knowledge and are recorded as a warning to future aspirants.

In the first place the fact that India does not possess accessible timbers capable of being converted into first quality match splints is undoubtedly proved. Such timbers are usually conifers, i.e., Spruce and Silver Fir, but in India these trees are only found at high altitudes on the Himalayas and the cost of transporting them over hundreds of miles of mountainous country excludes them at once for the match industry. In addition to the conifers there are one or two other trees whose timber would be suitable for making first quality matches such as Alder, Maple, Birch, etc., but here again such trees are only found at the back of beyond in the Himalayas and are ruled out at once on account of cost.

It is obvious therefore that for cheap timbers one must look to the low level forests of India but unfortunately the quality desirable for really first class match splints is not to be found among these woods. There are, however, certain species which will yield a timber suitable for making matches of a fair second quality and it is to these timbers that we must turn in the absence of anything better. Probably the best known of these timbers and the most universally used throughout India is the Semul (*Bombax malabaricum*). The wood of this tree makes up into fair splints, but like many of our softer Indian woods it stains badly and is apt to be 'cross-grained', producing a splint which breaks on striking. For boxes on the other hand Semul wood can hold its own with the imported article. Of other woods, perhaps *Trewia nudiflora* and *Excaecaria agallocha* are the most used but like Semul they are both liable to stain. In Central India *Boswellia Serrata* (*Salai*) is used with success and *Gmelina arborea* has been sought after but its colour is not good and although strong and tough it is apt to be cross-grained, besides being a not very common tree. The sapwood of *Populus euphratica*, a common tree in Sind, Rajputana and the Punjab is quite suitable for match-making, but the heartwood of this tree is unsuitable being very hard and of a reddish colour.

Various trials of Indian woods have been carried out from time to time but the results have not always been reliable and a word of warning will not be out of place to those intending to venture on the thorny path of match-making. In this connection the Department of Industries, Bengal, have lately issued an instructive pamphlet on the possibilities of the match industry in that Province and any one interested in this subject will find a lot of useful information in this publication (Bulletin No. 16, Department of Industries, Bengal).

Another useful publication is that issued by the Department of Industries, Bihar and Orissa (Bulletin No. 10) entitled 'Some experiments in the Manufacture of Safety Matches.' This pamphlet deals more with the chemical side of match manufacture but contains nevertheless information of extreme value to any one launching forth on a match-making venture. In the Bengal publication mentioned above, a long list of timbers tested both for splints and boxes under expert supervision is given. This list is probably the most reliable information on this subject available to date, but it refers of course only to Bengal timbers. In this connection there is another point of interest and a point which has proved in the past and will also in the future prove a very severe stumbling block to the manufacture of matches on a large scale in India. I refer to the distribution of suitable species. In countries like Norway and Sweden there are large tracts of pure forests containing one species of tree only and it is therefore comparatively easy to obtain a continuous supply of timber from these forests. If that timber is suitable for making into match splints then the foundation of a thriving industry is a matter of comparative simplicity.

India, on the other hand, does not possess pure forests of this type and even if a certain timber is found suitable for match making it is practically a foregone conclusion that the tree producing this timber will only be found scattered here and there, with probably not more than one or two to the acre, throughout the forest where it occurs. This of course is a severe handicap and the natural forests of India being such as they are the only remedy lies in planting pure forests. This sounds simple enough and the question may well be asked as to why the Forest Department has not taken the matter up before. The answer however is simpler still and the policy of the Forest Department will be found to be based on a sound and economic foundation. So long as the forest lands will grow such valuable constructional and furniture woods as Teak, Sal, Blackwood, Shisham, etc., it is not an economic proposition to grow timbers which will only bring in half or even one quarter of the revenue that these well-established timbers produce, and the price that a match factory can pay for its timber is very low indeed.

The match industry therefore is not one which holds forth such vast possibilities as it would at first appear. As a cottage industry success would probably attend it, but on a large scale the prospects are not bright. An enterprising concern might make a success of a venture with the conifer timbers of the Himalayas and even small factories on the plains of India can work up a paying business in second quality matches, but any large concern attempting to manufacture matches from the indigenous timbers of the plains forests is, in the opinion of the writer, launching a frail ship on troublous waters.

Before, however, dismissing the subject from our minds there is a ray of sunshine in the idea of making match splints and boxes from bamboos. The idea is not a new one and there is at least one enterprising firm in India at the present time which has found that the idea is sound and has proved it by practical results. The bamboo used to date has been the 'Eta' (*Ochlandra travancorica*) and the matches made from it are distinctly good. The process of manufacture and the machinery used differ considerably from those employed in the manufacture of wooden matches but owing to the fissibility of bamboo the manufacturing process is a comparatively simple matter. A bamboo is strong and absolutely straight grained, the two chief characteristics required for a match making material, and as bamboos are gregarious and obtainable in large quantities *in perpetuo* the outlook in this direction is, in the opinion of the writer, far brighter than that of the wooden match. Suitable machinery is of course the chief difficulty in the bamboo proposition, but once this has been overcome the horizon should be clear and the sky of success unclouded.

The subject of developing the timber trade would not be complete without mentioning the question of export and the possible lines along which the export trade might be developed. For more than eighty years there has been a regular export trade in teak, while the export trade in red sanders (*Pterocarpus santalinus*) and sandalwood (*Santalinus alba*) dates back to the 18th century, the former in connection with the dye extracted from the timber and the latter in connection with the essential oil. Blackwood (*Dalbergia latifolia*) and ebony (*Diospyros ebenum*) have also played an important part in the export trade for many years, together with Andaman *padauk* (*Pterocarpus dalbergioides*). It was not until more recent years that the export of other timbers was seriously attempted by the appointment of a Government Sale Agency in London (Messrs. W. W. Howard Bros.), who have succeeded in greatly expanding the export trade in species other than those mentioned above, such as *Terminalia tomentosa*, *Terminalia bialata*, *Xylia dolabriformis*, *Dipterocarp* spp., etc. It is not improbable that other markets might be developed and markets found for our timbers, especially of constructional varieties, in such countries as Egypt, Irak, and at ports along the East African coast.

The total exports of all species of timber is given in the following table :—

EXPORTS OF TIMBER FROM INDIA

Description	Average annual value for last 10 years
Timber other than railway sleepers—	Rs
Teakwood	3,12,00,275
Other timber	19,78,970
Wood—	
Firewood	1,99,773
Ornamental wood—	
Ebony	13,992
Sandal	26,48,122
Other kinds	1,94,703
Total ...	3,62,35,835

As regards a list of forest areas of promise and practical potential development, the following are the most important :—

i. Kanara in Bombay, i.e. West Coast.
ii. Wynaad and N. and S. Malabar in Madras.
iii. Coorg.
iv. North Bank and Jaipur Reserves, North Assam.
v. Chittagong Hill Tracts, Bengal.
vi. The Godavari forests in Madras.
vii. The Delta forests of Bassein, Burma.
viii. The forests of Mergui and Tavoy.

These are special areas in which little or no intensive management has hitherto been introduced.

CSL

(4) IMPROVED METHODS OF EXTRACTION AND EXPLOITATION

The three primary means of extracting timber and forest produce are railways, roads, and (for floatable produce) rivers. The value of many Indian forests is entirely dependent on rivers, for example, the coniferous forests of the Himalayas, the teak forests of Burma, the tidal forests of the Sunderbans, the bamboo areas of Chittagong ; without the cheap and easy floating afforded by the big rivers the enormous forest wealth of these tracts would to a great extent be locked up and useless. Roads play an important part in making available the produce of forests, but their radius of action is restricted ; bulky produce such as timber and fuel cannot support the cost of road-haulage over unlimited distances. For the more valuable timbers road-haulage is limited to about 40 miles or so, while less valuable produce, such as fuel, can only stand about 10 to 15 miles. For all forests which are not traversed by rivers and for all produce which is not floatable, railways (with a limited connection of cart roads) are essential. There are enormous tracts of forest in India at the present time which are served neither by rail nor river, and which are therefore rendered valueless. Every railway extension in the forest-bearing regions of India adds to the wealth of India's forests, and in most of the major provinces special officers or forest engineers are at the present time busy studying the possibilities, and preparing estimates of schemes for railway extensions, forest tramways and other means of mechanical extraction. The most striking example actually at work at the present time in India is perhaps afforded in the submontane *sal* forests of Nepal. In 1922 the Nepal Durbar constructed at a cost of under £30,000 a 25-mile length of light railway which has immediately rendered workable a block of virgin forest from which £1,000,000 worth of timber will be extracted in the next few years. The point of this illustration is that without the railway extension that virgin forest was valueless, and it emphasizes the claim frequently made by forest officers that money

CSL

spent on *sound* schemes for exploiting otherwise inaccessible but potentially valuable forests is the soundest possible investment, and adds to the general wealth of the country a sum out of all proportion to the initial capital expenditure involved.

(5) GREATER ATTENTION TO MINOR FOREST PRODUCTS

Emphasis has already been laid in a previous chapter on the great possibilities before an intenser utilization of minor products. In fact, in chapter V the main lines of expansion have been described and discussed in such detail that a brief résumé will now suffice. The production of resin and turpentine from the Himalayan pines will probably not show much further expansion, unless the problem of floating out resin efficiently and economically down the big rivers can be solved. A satisfactory solution of this problem would at once open up very extensive pine areas which are at present outside the radius of economic working. But the possibilities of development of *Boswellia* gum-resin are very considerable, and this industry is only now passing from the experimental to the commercial stage. The same may be said of the production of paper pulp from bamboos and grasses, where, as far as the available supplies of raw products are concerned, the possibilities of production are almost unlimited. The propagation and cultivation of lac is being strongly taken up in several forest areas of the Central Provinces, Orissa and Bundelkhand, and a great increase of revenue therefrom may be expected in a few years. The application of scientific methods of manufacture in the preparation of essential oils from scented grasses and of *cutch* and *katha* from *Acacia Catechu* has been previously discussed, and it is difficult to see why similar scientific principles should not be applied to the preparation of tannin extracts and concentrates, also drugs and medicines, from the raw materials in which Indian forests abound.

This brings to a close the brief review of the present wealth of India's forests and (as far as the scope of this little book has permitted) of some indications of possible future developments. In these days of transition from autocratic to democratic government, when an increased interest is being taken in Indian affairs by the intelligentsia and politicians both in Britain and in India, this book will have served its purpose if it makes information available on one aspect of Indian affairs which has in the past seldom received the publicity and consideration to which its economic importance and great possibilities entitle it. The autocratic government of the past has laid the basis of good forestry and a valuable estate on sure foundations ; it remains for the democratic government of the future to build up a worthy superstructure.

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